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A Cyclopaedia of Knowledge and
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VOLUME I

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Drawn by Scriven Bolton, F.R.A.S.

THE MIDNIGHT SUN.

During June the North Pole is tilted towards the sun which, in the Arctic Circle, remains continuously above the horizon, as the earth turns on its axis. In December the sun is never seen in the Arctic Circle; a prolonged darkness reigns, for the North Pole is then tilted away from the sun. *(See p. 28.)*

CASSELL'S
NEW POPULAR EDUCATOR

A FOREWORD

EFFICIENCY—without question, efficiency is the watchword of the day.

But what is efficiency ?

Simply this : the intelligent application of knowledge.

The efficient man is the man who has knowledge and the power to use that knowledge to the best advantage. But knowledge is not efficiency. Knowledge is the flower that blooms on the tree of education ; efficiency is the fruit. Unless the tree bear blossom, however, fruit can never form upon it, much less ripen. Knowledge, therefore, though not in itself efficiency, is essential to efficiency.

To the Man of Thirty

From bitter experience many men and women are learning this elementary truth to-day. The men and women, twenty-five, thirty, thirty-five years of age, in whose minds, during the days of their youth, the tree of education was neglected, in whose minds knowledge—the flower from which the fruit of efficiency is formed—has never bloomed, are becoming more and more conscious of their own deficiencies, of the burden of their handicap in Life's race ; and the majority despair of being able ever to lighten that burden.

This, so it seems to them, they can only hope to do by going, literally, to school again—a venture for which comparatively few have the necessary leisure, the necessary aptitude, or indeed the inclination.

The many prefer the line of least resistance, prefer to remain inefficient.

These people form one of the three large sections of society for whose benefit the *New Popular Educator* has been designed ; and we believe that those of our readers who conscientiously devote a portion of their leisure—say, two or three evenings a week—to the study of this work will soon, and with a facility surprising to themselves, increase their knowledge, and, therefore, their potential efficiency; and that, at the same time they will derive the pleasure and the satisfaction which the acquisition of knowledge presented in an attractive form alone can give.

To the Student

Next, the student proper—he belongs to the second section of society to which the *New Popular Educator* issues its appeal. We set out with the intention of preparing a work which would enable the lad or girl of average intelligence, using it as a text-book, to pass examinations up to the standard of the " London Matriculation." We venture to think that not only have we succeeded in this purpose, but that, thanks to the excellent work of our contributors, we are placing in the hands of the youth of Britain a work which will make easy for him examinations

1

of an even more formidable and searching character, and which will enable him to enter the arena of Modern Commerce confident, and well equipped for the tasks that there await him.

The *New Popular Educator*, moreover, is a work which can hardly fail to prove of great utility and value to every library and every home—the more so on account of the fullness of the Index—as a cyclopædia of knowledge and general information.

Answers, at once simple and full, are given to most of the many ever-recurring questions which arise when any subject is discussed, be it mathematical or scientific, literary or historical.

To the Teaching Profession

Lastly, we address the teaching profession. The *New Popular Educator* covers a very wide range of subjects ; and the chapters or " lessons " on each of these subjects have been written by eminent writers, of whom the majority are actively engaged in the actual teaching of the subjects upon which they write.

The *New Popular Educator*, therefore, represents the last word in teaching and in teaching methods ; and the many illustrations, charts, maps, and diagrams which fill its pages will be found—by the teaching profession in particular—full of inspiration and helpful suggestion. One well-chosen picture can be more explanatory than many well-chosen words.

To the General Reader

A glance at the first few pages will show that the subjects which the *New Popular Educator* includes in its curriculum are grouped, for the convenience of the student, in Sections, as follows :

English Language and Literature. (*See* p. 3.)
History. (*See* p. 7.)
Sciences. (*See* p. 15.)
Languages. (*See* p. 33.)
Geography. (*See* p. 38.)
Art and Music. (*See* p. 43.)
Mathematics. (*See* p. 51.)
Business and Commerce. (*See* p. 56.)

This Sectional arrangement is maintained throughout the work ; and at the end of each chapter or " lesson " may be found the initial letters of the author's name which appears in full in the Section heading.

Exercises are set in connection with subjects which specially call for them. Keys to these Exercises are given at convenient intervals.

ENGLISH LANGUAGE AND LITERATURE:

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THE STUDY OF ENGLISH

ALL those who by birth and upbringing have a natural knowledge of the English tongue are joint-heirs in a great inheritance. They have a share in a language which has an unbroken record of more than twelve centuries, and a literature which is as old and as continuous. A rich heritage, however, will not yield its full profit to a possessor who is not prepared to spend time and labour in managing it rightly.

Literary Appreciation

To understand and appreciate any literature properly, it is necessary to have a thorough knowledge of the language in which it is written. All great literature is great not merely in virtue of the subjects with which it deals, however important or interesting these may be, but also by reason of the artistic skill with which its authors have employed their native tongue in poetry or prose. In highly-developed literatures, especially those which have flourished for several centuries, it is inevitable that many words, phrases, and allusions must occur which are unknown, or at least are not perfectly familiar, to the great majority of readers. To this extent, therefore, the language as employed in literature must be acquired by special study, partly devoted to the literary works themselves and partly to other sources of information.

That English is worthy of such study, and will richly repay the student for his pains, is a fact which ought not to stand in need of demonstration, but there are some points which may readily be overlooked. The very ease with which much of the finest English literature may be read may tend to make its greatness less obvious or less impressive.

It is natural to admire, even to enthusiasm, the literatures of ancient Greece and Rome, or those of Italy, Spain, and France in later times, but admiration for these ought not to make any English speaker forget that his own country has a proud place in the literatures of the world—that from Chaucer to the present day, and even from still earlier times, the English tongue has been employed in works which rank as high as those of any country or age. If the student, therefore, is prepared to undertake the long and difficult task of mastering a foreign tongue for the sake of its literature, he ought all the more readily to undertake the complete conquest of his own, not only as it exists at the present day, but as it has been in the past.

The Origin of Phrases

Scores of common phrases, used without a thought by every speaker and writer, are not ordinary modes of speech which might originate in any person's mouth; they are the inventions of individual writers, in which some idea has been so happily expressed that no other words seem able to render it. Many of them come from Shakespeare or the English Bible; many more have been picked up here and there from the multitude of English writers. Of such origin are the phrases "a very perfect gentle knight" (Chaucer), "very like a whale," "caviare to the general" (Shakespeare), "apostolic blows and knocks" (Butler), "the light fantastic toe" (Milton), and many more of the kind. Whoever reads most widely in English literature will be most surprised at the number of common phrases he will thus trace to their sources.

If this study of English is to be made, the best means of undertaking it deserve careful consideration. As has been said above, the language and literature have a continuous

record of more than twelve centuries (for the oldest English dates from before A.D. 700), and a history of either naturally begins at the earliest point and traces development and growth through successive periods down to the present day.

The Age of Shakespeare

The old English tongue, the speech of the Anglo-Saxons, for several hundred years after it first appears in written records differs so much from the English of the present day that it can be read only after much study, and even the best scholars are frequently uncertain as to the true meaning of words and passages. For the student to begin at this end would involve prolonged study of an extinct form of the language, and would consume time which, spent on other lines, would yield a far greater harvest of knowledge.

The beginner will do better to approach the study of English from a different point, from the language and the writers of a later age—not necessarily those of his own day, but at any rate from that period during which the English tongue has undergone no very remarkable change. This period may be regarded as virtually beginning towards the middle of the 16th century, but for the majority of readers it really opens about 1590 with the later poetry of Spenser and the early plays of Shakespeare. In the twenty or thirty years that followed, the immense literary vigour of that age reached its climax, but its impulse continued to manifest itself with only gradual abatement until well into the third quarter of the 17th century.

During this period of a century or more the English language was at one of its culminating points, combining the riches of both the older and the newer times, and luxuriating in a wealth of vocabulary and idiom which has rarely been equalled in any tongue.

Excessive Latinism

After this climax of energy and exuberance a reaction set in, the effects of which became clearly marked before the end of the 17th century. Precision now took the place of picturesqueness, luxuriance was repressed by a spirit of selection, and English became either trimly neat or severely ponderous according to the natural bent of the writer. As the result of this tendency, it is in the poetry and prose of the 18th century that the untrained reader will find least to puzzle him, so far as the mere language is concerned. Few authors employ rare words; most of their vocabulary is still extant and in common use, though a part of it may have dropped old senses or developed new ones.

In all the poetry of this period, from Dryden and Pope to Rogers and Crabbe, and in most of the prose-writers from Locke and Burnet to Gibbon and Burke, there are few difficulties. Even the excessive Latinism with which some of the writers can fairly be charged offers no great difficulty; it does not consist so much in using more words of Latin origin than are current in the modern language, but in piling a greater number of them into each sentence,

It is in this period, therefore, that the student will find the easiest material upon which to commence the systematic study of his native tongue.

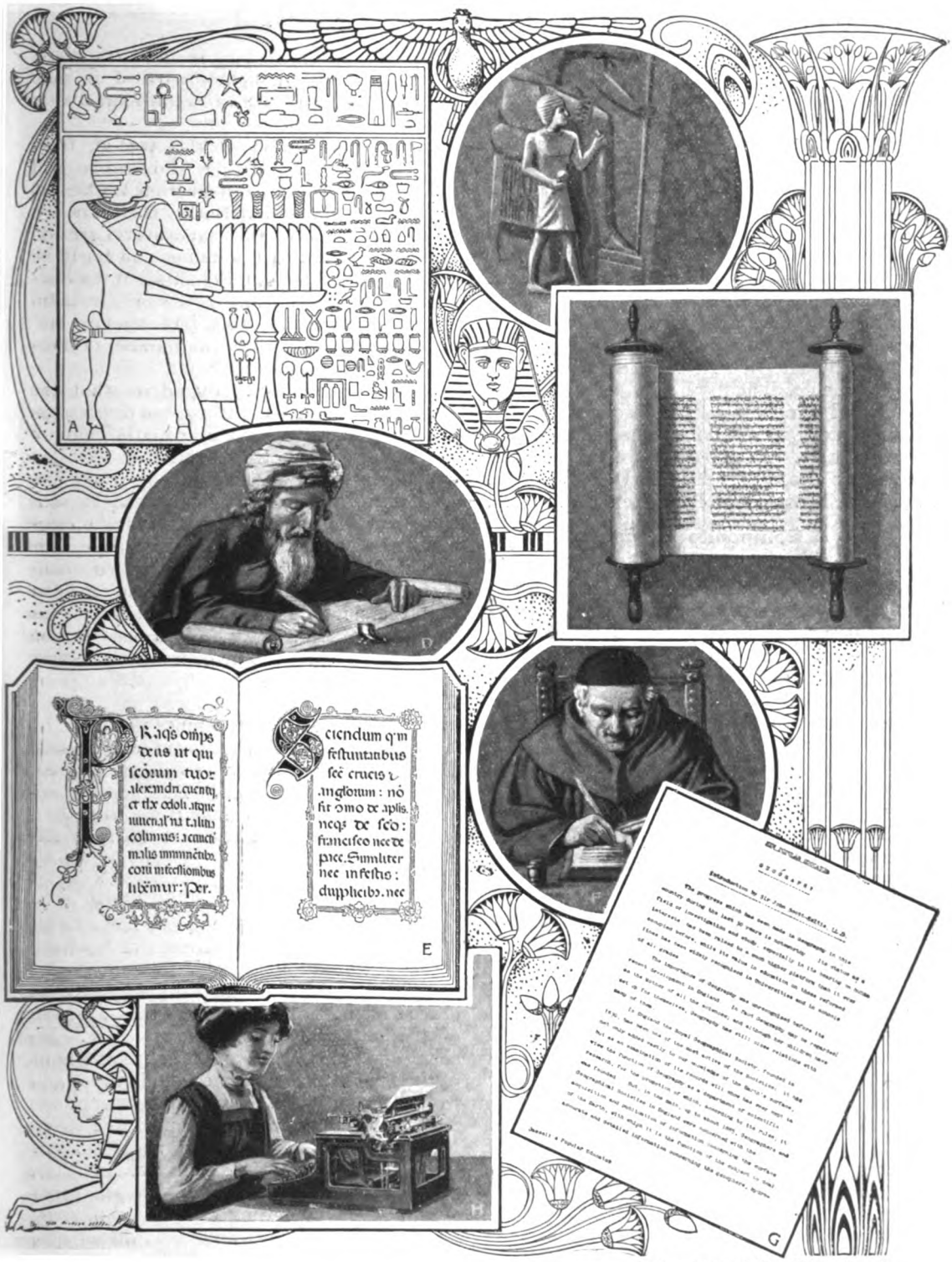
Towards the end of the 18th century new literary currents began to flow which soon brought with them a considerable change in language. The romantic movement and the historical novel rapidly revived many words which had been out of use for two centuries or more, and this tendency was furthered by an increased, in some respects a new, interest in Elizabethan and Stuart literature.

Changes in Language

The writing of dialects, especially those of Scotland and northern England, operated in the same direction, and this source of enrichment has steadily increased in recent times. On the other hand, the rapid progress of science and of the mechanical arts has added an immense number of new words to the language; many of these remain purely technical, but many have also become an essential part of the ordinary speech of ordinary men.

The result of all these influences is that English of the present day is a language with an immense vocabulary of the most varied character. To know modern English fully, or even well, is thus no small matter, and can only be attained by dint of study.

In this respect the language of the present time has its counterpart in that of the Elizabethan period, as has been indicated above. The full understanding of Elizabethan literature requires more study of the language than is at first apparent, for many words which are still current have considerably changed in meaning. A good instance of this is the use (in two passages) of "relish" in the sense of "to sing," "to warble"; it is only in recent years that the distinction of this from the usual word "relish" has been noticed. The



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THE AUTHOR OF YESTERDAY AND TO-DAY.

Showing the four great stages which mark the evolution of the production of manuscripts—from the time of the ancient Egyptian who worked on tablets of stone to that of the modern novelist who dictates to a stenographer.

chief difficulty, however, arises when the difference in sense is not so strongly marked as to be obvious, but at the same time is sufficient to alter the whole tone and bearing of the passage.

Beyond the period of Shakespeare and Spenser the need for special study naturally increases in proportion to the earliness of the author, and the " Middle English " of such writers as Chaucer and Langland can only be mastered by those who take it as a serious task. With the aids now available, that task is easier than it formerly was ; in addition to some points of grammar and prosody the chief difficulty lies in the vocabulary, much of which is either obsolete and unfamiliar, or appears in forms not immediately recognisable. Even here, however, the student may already be possessed of knowledge which will considerably lighten his labours.

A Composite Language

He may have an acquaintance with French, and in that case he will find that many of Chaucer's or Langland's words are still represented in that language, from which they were simply adopted for a time in Middle English and afterwards dropped out of use. He may also be acquainted with some modern dialect of English, and will then be surprised and interested to discover that words only known to him in this connection formed part of the usual language of poetry in the 14th century. To such a reader Chaucer's *balke* (beam), *glede* (glowing coal), *ilke* (same), *rakel* (rash), *siker* (sure) will be readily intelligible, and no one who in his native district ever heard of " a fern-year cheese " will require to turn to the glossary to discover the meaning of the line " Yea, fare-wel al the snow of ferne yere."

As has been said above, the greatness of English literature would alone call for and justify a careful study of the language in which it is written. There is, however, still another reason which makes such a study profitable. English is a composite language, in which two main elements are combined with many smaller. One of these consists of words which have either remained in use from Anglo-Saxon times, or have been adopted at various periods from closely related languages, especially those of Scandinavia or the Low Countries : these constitute the Germanic or Teutonic portion of the language. A large proportion of these words are still in use in all the languages of the Germanic group, consequently the English-speaking student of such languages as Dutch, German, Danish or Swedish is already familiar with a considerable part of their vocabulary. The more English he knows (including dialect and older English) the more rapidly he can acquire any of these languages.

The second main constituent of English is the Latin or Romanic element. This existed in a small degree from an early period, but only began to be prominent about 1200, or nearly a century and a half after the Norman Conquest. After that date it increased rapidly in amount and importance, and within another century had definitely established itself as an integral and indispensable part of the language. By degrees a great part of the Latin vocabulary was thus transplanted into English, in forms either closely adhering to the Latin originals or modified by passing through French.

The result of this is that modern English has a very large number of words in common not only with Latin, but also with French, Italian, Spanish and Portuguese, and these words usually differ so little in form that there is not the slightest difficulty in recognising them. Any English speaker who proposes to learn one or other of these languages should therefore realise at the outset that he already knows a large part of the vocabulary, and that the more perfectly he is acquainted with the Latin element in English the more easily he will master any language of Latin origin. Taking the Germanic and Romanic languages together, English is the meeting-point of half the languages of Europe.

The Vehicle of Thought

The chief point to be noticed, however, is that for the full accomplishment of his work the student of English literature must also be a student of the English language, in order to appreciate its true value as a vehicle of thought and means of expression. He should be able to read an author in the light of the language as it existed in his time, and to understand the difference between one writer and another in their mode of using their common tongue. He should know whether a rich vocabulary, a precise style, or other characteristic, is a special merit of a particular author or merely a usual feature of a period, and should be able to mark the points at which changes in these respects begin. Such a knowledge of English is not a mere matter of grammar or philology; it is the only means of understanding and appreciating that mastery of the language which all great writers must possess.

W. A. C.

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THE CITY-STATE OF ANCIENT GREECE

As an introduction to the study of modern history, some knowledge of the history of ancient Greece is invaluable; indeed, almost essential.

What we call History is not merely a chronicle of names, events, and dates. History is a science—the science of nations; and, just as a thorough grasp of the rudiments of chemistry enables one to understand with comparative ease the most abstruse of chemical changes, so the seemingly complex political changes which constitute modern history become a thousandfold more intelligible if one has first studied the genesis and gradual development of those institutions and conventions which have made the corporate life of nations possible.

Now the book of History contains a chapter in which is traced the growth, or evolution, of political institutions in their simplest and most perfect form. The chapter deals with the fortunes of the inhabitants of the south-eastern peninsula of Europe, the land known to us as Greece, during—roughly speaking—the years which elapsed between the seventh and third centuries before Christ.

Civilisation's Working Model

It is permissible, perhaps, to describe Greek civilisation as the working model upon which was based the subsequent civilisation of the whole continent of Europe. And this it is which renders Greek history a valuable preparatory study to the would-be historian, since the mechanism of the model, being less intricate, can naturally be understood more easily than that of the great engine fashioned after it. Besides, it is important that one should realise how profound was the influence which Greece, through Rome, exercised upon Europe, to whom she gave, as it were, the first and all-important lessons in political management.

The Greeks, or Hellenes as they are more accurately known, despite a community of blood, language, and religion, never during the period of their greatness formed themselves into what is termed a nation-state.

In ancient Greece, or Hellas, there were a number of very little states, so little that at first one may be tempted to think that an absurdly exaggerated importance has been attached to them by historians. Yet it was mainly by virtue of their littleness that the states of Greece—Corinth, Sparta, Argos, Thebes, Megara, Athens, and the rest—made an indelible impression upon the development of the human race, for political, social, and intellectual forces were so closely concentrated in those small states that it was possible for them to be controlled and organised in a way which neither the progress of civilisation nor the conveniences of science have made feasible even in the great European states of to-day.

The Modern State

By a State, in the modern sense of the word, we understand one of two things—either a large tract of country controlled, as is the case, for example, in France and Russia, by some form of central government carried on in the capital city; or a group of such territories, each with its own government and capital city, but joined together, as are the United States of America and the cantons of Switzerland, in a federal league.

To such states the capital city is not in itself of vital importance. It is merely regarded as a convenient seat of government, which, if circumstances require, can easily be moved.

History abounds with instances in which this has actually occurred. In mediæval England, for example, there was no rigidly fixed seat of government; the government of the country was carried on from wherever the King might happen to be at any given time—London, Winchester, Windsor, or even Marlborough. During the Civil War, again, Charles I. automatically transferred

the seat of government from London to Oxford; whilst during the Franco-German War (1870–1), and again when German armies invaded France in 1914, the authority of Paris—a city representative of the people whose capital it was to a greater extent, probably, than is the capital city of any other European country—was in a similar manner delegated to Bordeaux; but in none of these cases did the mere act of transference in any way dislocate the machinery of state.

To the mind of a Greek this would have been utterly incomprehensible, for to him the polis (πολις) or capital city was of very vital importance to the state; and for this reason—it was the state.

From time to time, it is true, two or more states would band together for the purpose of military defence, but, despite the formation of such leagues, the federal idea never became popular, and states, although bound by alliance or necessity to fight together, still cherished and rigorously guarded their individual rights and liberties.

No Imperial Conceptions

Moreover, even when a weak state, as sometimes happened, came under the dominion of a state stronger than itself, it never wholly lost its separate character; whilst the very colonies sent out from the cities of Greece soon became separate entities, acknowledging perhaps moral obligations to the Mother State, but being in no way subject to her.

The Greeks, in fact, unlike the Romans, had no true conceptions of imperial greatness. Each man focused his activities upon the actual πολις to which he belonged; and his one ambition was to see that city, not the mistress of vast territories and countless vassal states, but to see it a beautiful city, a well-governed city, a city that men should delight to live in.

Of course, each of those City-States claimed a certain territorial sovereignty, but politically this land had little importance; it was regarded mainly as an adjunct from which the citizens could derive the necessary means of subsistence.

Belonging to the state of Athens, for example, was the territory known as Attica, a piece of land approximately equal in area to the county of Kent, and of which, according to our way of reasoning, Athens was the capital city. But, as a matter of fact, Athens was the actual state; and although free men living on the soil of Attica, as well as those living in the city, could claim membership of that state, they were entitled to political privileges not as inhabitants of Attica, but only as Athenian citizens.

The Greeks, like ourselves and most of the peoples of Europe, were of Aryan descent—that is to say, they belonged to that great division of the human race which, at some remote prehistoric period, swept over Europe in successive waves from the East, and gradually conquered the whole continent.

Greek and Phœnician

Now the original line of invasion appears to have been through Persia and Asia Minor, and then across the Hellespont. Hence it was only natural that the Balkan Peninsula, owing to its geographic situation, should have been the earliest place of settlement. The Greeks, at any rate, were the first of the Aryan nations in Europe regarding whom we have any reliable testimony; and with their history may be said to begin the history of modern civilisation. Whether the mainland of the Balkan Peninsula was inhabited at the time of the Greek migration it is impossible to say with certainty. We know, however, that the Greeks found already settled in the neighbouring islands a very powerful and progressive people—namely, the Phœnicians.

The Phœnicians were a Semitic people hailing from the coast of Palestine round the great cities of Tyre and Sidon, and they appear to have attained a far higher degree of civilisation than any other people not of Aryan descent. They were great traders, great travellers, and thoroughly understood at any rate the rudiments of free government.

The Letters of Cadmus

Their influence upon the subsequent course of Greek civilisation was very considerable. Phœnician religion affected Greek religion; Phœnician institutions, Greek institutions; whilst the Phœnicians also handed to the Greeks a gift which, as Professor Oman asserts, was "far more valuable than the perishable luxuries from Egypt and Assyria, which formed the main staple of their traffic."

This gift was the Alphabet, or the "letters of Cadmus," as the Greeks called it, in acknowledgment of the genius of a mythical Tyrian of that name, who is alleged to have invented it.

The alphabet came generally to be adopted in the Hellenic world during the course of the tenth century B.C., and from Greece the "letters of Cadmus" gradually made their way to Italy, and so over the whole of Europe, each nation adapting them to the needs of its own speech.

One must not imagine that the Greeks, when first they came into Europe, were either highly civilised or highly organised. They were at that time merely a nomad race, and no migratory people ever possessed political institutions or an established machinery of government. Land is the basis of the state. It is impossible, therefore, for a people to form a state until they have definitely chosen, and settled in, some given territory.

Prior to the settlement, a migratory tribe will be found to consist of a trunk of family groups, held together by the tie of kinship. These groups will still remain after the settlement has taken place, but they will now be fixed definitely upon the soil in the form of what is commonly termed "village communities."

Here we have the germ of a political organism—a community sharing a certain given extent of soil, united by a common kinship and some common form of worship, and governed by a council composed of the heads of the various families in the group, the council being presided over either by an elected chief or by the head of the leading family in the group, whose members were in many cases held to be of the blood of the gods.

In certain circumstances—for example, when a common danger threatened—it was the obvious thing for a number of such communities to join together and form a larger community; then for a number of these larger communities to join together to form a still larger community; and so forth.

This actually happened, to take a case in point, when in the ninth century A.D. the Danes threatened England. Practically all the various units of which the country was composed then united under the leadership of King Alfred to repel the invader; and England became a Nation-State.

The development of this State naturally proved slow and laborious. The central authority was weak, distances were out of proportion to the inadequate means of communication; whilst local groups and local councils were very jealous of their immediate rights and privileges.

But in ancient Greece, as we have shown already, the welding together of the Hellenic race into a national whole never came about.

THE LADY OF FASHION

in Athens of old was, owing to the prevailing high standard of civilisation, confronted with social and domestic problems as complex as those which confront the lady of fashion in Western Europe to-day.

Greece, owing to a series of peculiar circumstances, remained, throughout the era of her greatness, a country made up of a number of small, independent communities, whose polished life consequently developed with remarkable rapidity, and with a logical sequence impossible in great countries such as France or Britain, where extraneous influences have always been at work.

Geographic factors were largely responsible for the formation of those politics peculiar to the Hellenic people.

The sea coast almost invariably is the first part of a country to become civilised, owing

to the facilities which the sea provides for the carrying on of trade with neighbouring lands.

Now Greece has a remarkably long coast-line. It is a very rugged coast, moreover, broken up into innumerable small peninsulas and islands, each of which forms, as it were, a separate and secure place of habitation.

Everything tended, therefore, to encourage the early groups of Greek settlers each to become self-contained and self-supporting on its own little plot of land. Further, some centuries elapsed before a serious unifying influence was brought to bear upon them in the shape of a Persian invasion (490 B.C.) which menaced the whole of Hellas; and by that time the little states of Greece had all acquired their stubborn individual characters.

From Monarchy to—

Thus although they worked together in some measure to repel the common enemy, they had no more idea of ultimate fusion, when doing so, than had Great Britain, France, and Russia when in 1914 they took up arms together to free Europe from the menace of German military despotism.

The Greeks recognised as legitimate three forms of government—Monarchy, Aristocracy, and Democracy. Of these monarchy was the oldest and most primitive. During the earliest times, that is to say throughout the so-called Heroic Age, each city or state had its king, whose office was hereditary and whose functions were threefold. He was the chief priest, chief magistrate, and head of the army. But he was not an autocrat, for he had always to consult a council of chiefs or elders, which may be compared to the Witenagemot of the early English kings; and in a small community the fact that the people were also allowed to attend those meetings, and to express approval or disapproval of decisions was an effective check on the royal authority.

—Aristocracy

The king, in fact, never succeeded in acquiring clearly defined prerogatives, and, in consequence, his power steadily declined. Thus, although in some cases—notably that of conservative Sparta—the kingly office was carefully preserved as a picturesque relic, kings gradually ceased to be an important factor in political life, and at the time when the history of Greece really begins, the actual power had passed from the hands of the king into those of the chief men of the state. We must now, therefore, consider the second of the three forms of government mentioned above.

The Greek word ἀριστοκρατια, from which is derived our "aristocracy," literally means "the rule of the best." An aristocracy, therefore, should be a government by persons of superlative moral qualities.

But it cannot be said that this was the case with the Greek aristocracies, for, like more recent oligarchies, they secured power by virtue of wealth or noble descent rather than of moral excellence; though, writes Mr. Warde Fowler, "we can hardly be wrong in believing that the excellence (ἀρετη) which they claimed for themselves . . . had at one time had a real existence."

But aristocracies, since they tend to grow narrower and narrower in their views, must eventually fall into disrepute with the people whom they govern, and who, under competent rule, increase in intelligence, and so grow imbued with the desire to manage their own affairs. Class war, in fact, becomes inevitable.

In small states, such as were those of Greece, it is comparatively easy for the masses to act in concert. The struggle between the nobles and people, therefore, is sharper and more intense than in large nation states. This affords an obvious opportunity for a strong man to come forward from one of the two parties and establish himself as an autocrat, a tyrant.

Aristotle on Tyrants

Now tyranny, a form of government to which practically all the States of Greece were subjected during the course of the seventh and sixth centuries B.C., was not recognised by the Greeks as lawful.

"Tyranny," declared Aristotle, "is monarchy used for the advantage of the monarch." But it would be a mistake to regard all tyrants as bad. Indeed, some of the ablest and most progressive of Greek statesmen—men such as the great Peisistratus, who came into power in Athens about 560 B.C. —were tyrants. None the less the majority of tyrants undoubtedly were bad, as also was the system which they represented; hence the word came to bear the stigma which is still attached to it.

In some cases, aristocracy survived the constitutional struggle between the nobles and the people, but in others—notably that of Athens, regarding which we shall have more to say later—Democracy, i.e. the rule of the δημος, or people, ultimately triumphed.

Prior to the Persian Wars, which began with the expedition sent over from Asia by King Darius in the year 490 B.C., Sparta was the predominant state in Greece. But

MAP OF ANCIENT GREECE.

Geographic factors—the ruggedness of the country and its extensive sea-board—had much to do with the formation of those politics peculiar to the Hellenic people.

Athens, at this time emerging from the throes of tyranny, found herself better fitted, on account of her maritime strength, to lead the states of Greece in their struggle with the Persians than did Sparta; and by the end of the war, 479 B.C., had attained a position of importance in Greece such as no state hitherto had held.

During the half century which followed, Athens rose to the summit of her splendours and, guided by wise counsellors—Aristeides, surnamed the Just, and Pericles, a statesman even greater than Aristeides—realised that Democracy, the fame of which will always live in the annals of history.

But the very power of Athens brought about her downfall. Other cities grew jealous. A league was formed against her under the leadership of Sparta; and in 431 B.C. began the Peloponnesian War which continued for twenty-nine years and ended fatally for Athens, who lost for ever her political greatness, though she still retained her freedom.

Sparta then once again became the pre-eminent State, and continued to hold this position until 379 B.C., when she in turn was forced to yield precedence to the rising power of Thebes.

But by this time the days of Graecian freedom were almost over. In 338 B.C. the country was overrun by Philip of Macedon, and a few years later by Philip's son, Alexander the Great, who practically brought the

whole of Greece within his empire; and from the toils of Macedon Greece never wholly escaped until she and her wonderful civilisation were finally absorbed by Rome.

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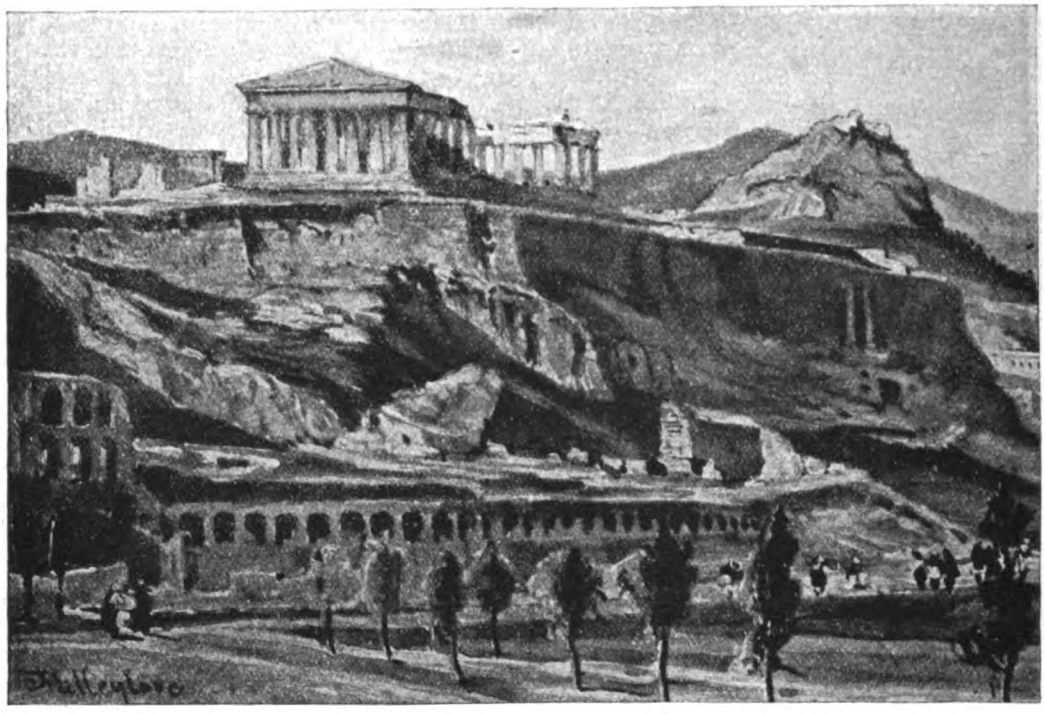
The historian Thucydides has left on record the words of a speech in which Pericles summed up his conception of the Athenian democracy form of government which he himself brought to its perfection.



"THE GLORY THAT WAS GREECE."

A view of the Acropolis of Athens as it is to-day—*see opposite.*

"It is true," said the great statesman, "that we are called a democracy, for the administration is in the hands of the many and not the few. But while the law secures equal justice to all alike in their private disputes, the claim of excellence is also recognised; and where a citizen is in any way distinguished, he is preferred to the public service, not as a matter of privilege, but as a reward of merit. . . .

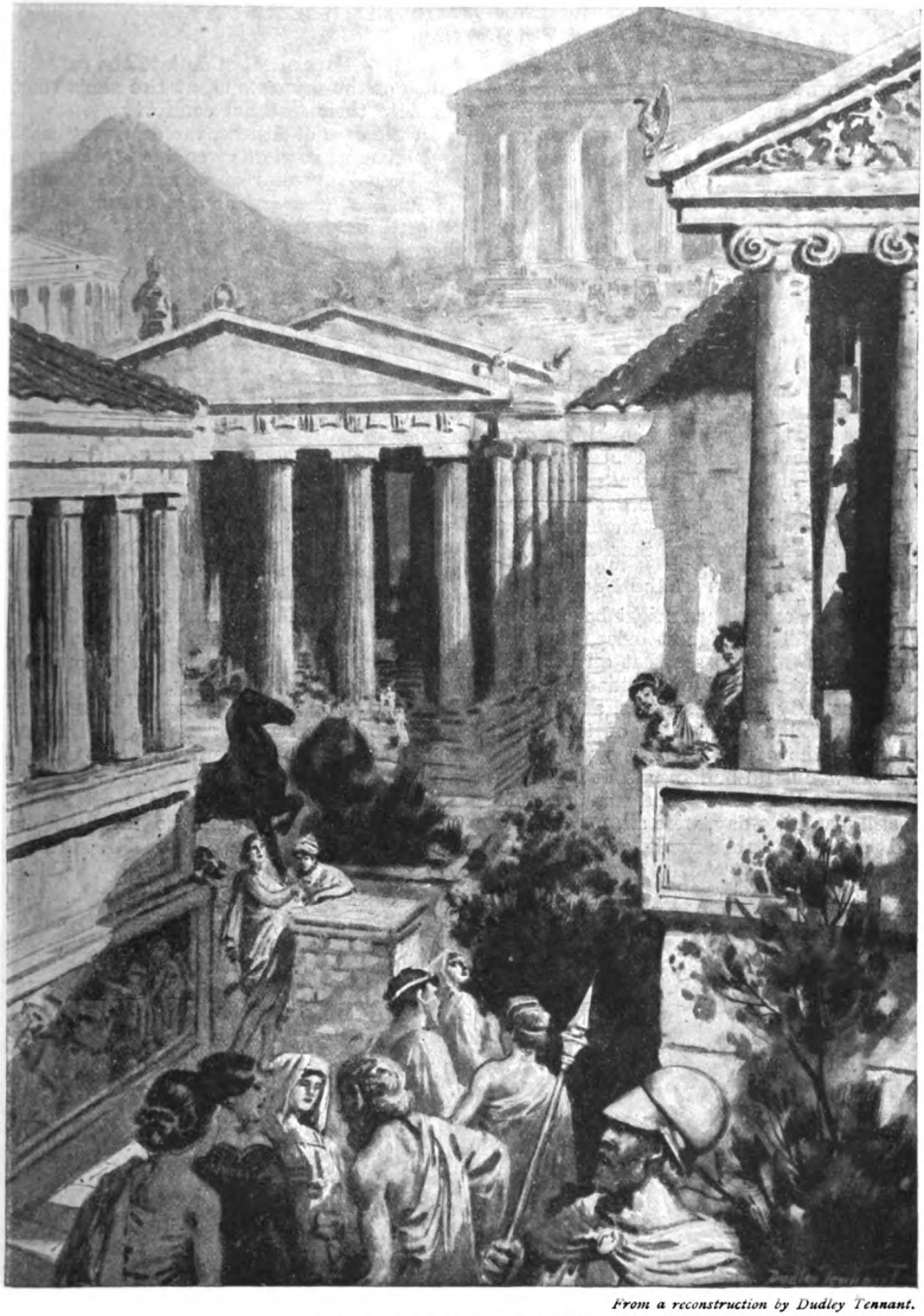
"There is no exclusiveness in our public life," continues Pericles, "and . . . a spirit of reverence pervades our public acts; we are prevented from doing wrong by respect for authority and for the law."

But why, one may ask, should the average Athenian citizen have had a greater respect for authority and the law than the average citizen of any other state? The answer is this—that throughout his life each citizen was himself associated with the maintenance of authority and the making of laws.

We call the British constitution a democracy, but we cannot truthfully say that Britain is governed by the people. The country, it may be, is governed by a ministry which has to rely for support upon a House of Commons elected by the people, but frequently, for years on end, no questions of national importance are referred directly to the people.

At Athens, on the other hand, during the best days of the democracy, the people could always and at any time assert themselves—indeed were compelled to do so by the very nature of the constitution.

In the first place, every citizen was entitled to sit and vote in the General Assembly (ἐκκλησια) which constituted the sovereign body of the state, and to which all matters of national importance were ultimately referred. Similarly, every citizen could sit and vote in the Oikasteria, or Law Courts, which was the supreme tribunal and from which there was no appeal.



From a reconstruction by Dudley Tennant.

THE ACROPOLIS OF ATHENS

as it was in the days of Pericles (450 B.C.). Round the base of the hill, which rises 150 feet from the Attic Plain, are grouped numerous temples and theatres—the Temple of Dionysus, the Theatre of Æsculapius. The Parthenon and the Erechtheum are among the famous buildings on the summit.

Again, the bulk of the business of the State—the work which in Britain nowadays belongs to permanent government officials, magistrates, and so forth—was performed by a Council of 500 citizens, elected annually by *lot*, and rarely, if ever, re-elected.

This Council was assisted in its administrative work by various boards. Thus there were nine Archons, who were high executive officers, ten Strategi, or generals, and boards of education, finance, and so forth.

All those officials, with a few obvious exceptions—it would have been ridiculous, for example, to elect the ten generals by lot—were chosen in exactly the same way as the members of the Council; and during the days of Pericles there were as many as 1,400 of them in office at the same time, so that, including the members of the Council, nearly 2,000 citizens out of a total population of 30,000 males were employed annually in the service of the State.

The Education of the People

Now, since any citizen might be called on one day to fill the highest office, it clearly behoved the State to see that all its members were persons of understanding. The Athenians fully recognised this, and accordingly devoted a large part of the public wealth to the education of the people.

Those wonderful buildings, that inimitable statuary, at the remains and ruins of which we still marvel to-day, were all, for example, paid for out of public funds, and erected in order that they might stimulate the æsthetic tastes of the masses and, at the same time, promote their material comfort.

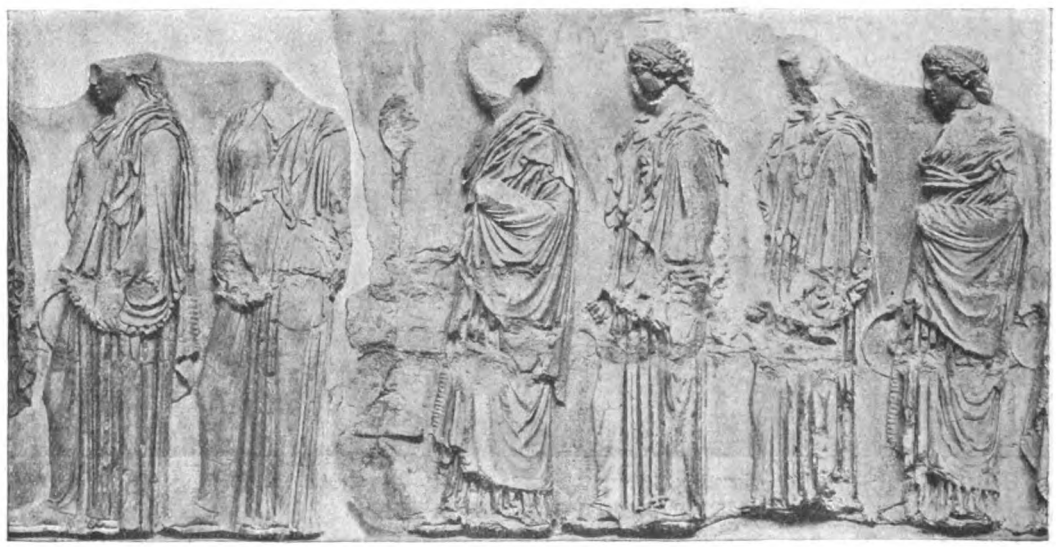
In the case of Athens, the encouragement and financial support given by the State to intellectual pursuits disproves the popular dictum that true artistic and literary genius is bred only amid uncongenial surroundings.

Indeed, has any nation produced a sculptor to rival Phidias; dramatic poets such as Sophocles, Euripides, Æschylus, and Aristophanes; a philosopher like Socrates; a statesman like Pericles; or a Themistocles to write the history of his times?

Athenian Socialism

Now, to the casual observer, that democracy is apt to appear as an irrefutable justification of Socialistic theories, and of Communism—for in Athens the amassing of wealth was strongly discouraged; the State contained very few rich men, and those few were taxed remorselessly. A word of warning is, therefore, necessary. Athens was not a Socialistic State. Only free men could enjoy the privileges of citizenship; and in the community free men were in a minority.

The ranks of the industrial classes were filled up with slaves, slaves who had no rights and whose only privilege was to toil in order that their masters, the citizens of Athens, might be free to strive after that "good life" which was the ideal of the statesmen of the Democracy. J. A. B.



ATHENIAN WOMEN AT THE FEAST OF THE PANATHENAIA.
From a Parthenon bas-relief by Phidias.

SCIENCES:

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NOTES ON COMMON SCIENTIFIC APPARATUS

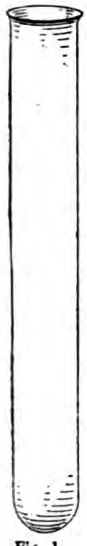


Fig. 1.—Test Tube.

In order to study any branch of science, experimental work is imperative, and the student who cannot obtain access to a laboratory should on no account grudge either the time or the comparatively small outlay required for his practical work. An experiment is not merely a check or test of results suggested in theoretical expositions, it is also a means of discovery.

We propose in these notes to offer a few general hints to students of Chemistry and Heat in particular, but to students of other sciences also, regarding the apparatus of most general use in the practical work of those subjects. The apparatus suggested will be for the most part inexpensive; it is readily obtainable from any dealer in scientific apparatus. Skill in using it comes only with practice.

1. Glass Apparatus.—Much work is done in vessels of thin glass which can be safely heated without cracking. Especially useful are the *test-tube* (Fig. 1), the *beaker* (Figs. 3 and 4) and the *flask* (Fig. 5). These things, of course, are obtainable in various shapes and sizes. Experience will teach which shapes and sizes are suitable for particular purposes.

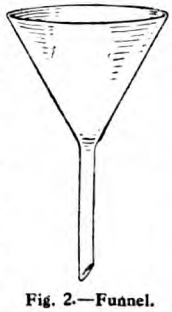


Fig. 2.—Funnel.

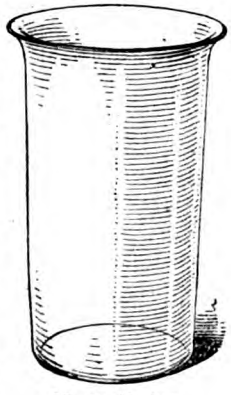


Fig. 3.—Beaker.

Fig. 5.—Flask.

The *test-tube* should be about 5 in. by ¾ in. The test-tube is heated by holding it in the Bunsen flame, moving it about gently so that the heat is not too closely localised.

The *beaker* is a kind of thin glass tumbler, and is made in the tall or the broad form. For general purposes the 10–12 oz. size is useful; a smaller size is often serviceable in Chemistry.

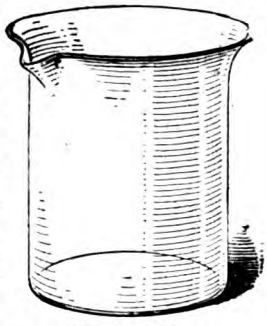


Fig. 4.—Beaker.

The *flask* is a bottle with a long neck. The student should provide himself with two 6-oz. and two 8-oz. flasks of the flat-bottomed type, and one 8-oz. flask of the round-bottomed type. He should at the same time have them fitted with india-rubber bungs with two holes in each. India-rubber is expensive at present, but is preferable to cork for many purposes; it is not, however, indispensable. The flask is quite indispensable in the majority of chemical and physical experiments.

One or two glass *funnels* about 2½ in. to 3 in. in diameter are useful (Fig. 2).

Glass tubing is a necessity for connecting the different parts of apparatus together. It is usually sold by the pound, and a pound each should be bought of diameters 4 mm. and 6 mm. The soft tubing employed can very easily be bent

at any angle desired. It should be held in the luminous flame of an ordinary gas-burner until it is quite soft; then removed from the flame, and bent as desired. The bending should not be done too rapidly, nor should it be done in the flame itself if a good bend is to be obtained (Fig. 19).

In order to close one end of a tube, it should be held in the non-luminous Bunsen flame until the glass melts: in its soft condition the glass readily closes up the aperture of the tube. In this state it is also easy to make a bulb on the tube by blowing steadily down it.

Capillary tubing, with a very narrow bore, can be bought with bulbs ready blown for thermometers. One or two thermometers, graduated from $-10°$ C. to 110° C., are indispensable, and not expensive (Fig. 18).

Two yards of india-rubber tubing of about the same diameter as the glass tubing will be necessary, to join up separate pieces of tubing; pieces of rubber about $1\frac{1}{2}$ in. long serve this purpose well (Fig. 13).

Solid *glass rod* for stirring liquids is necessary in Heat, and should be at least 4 mm. in diameter. Glass rod, like glass tubing, can be cut to any length desired, by making a clean scratch with a sharp triangular file and breaking between the fingers. A clean fracture ought to be obtained in this way: if it is jagged, hold the rough end for a moment in the Bunsen flame.

A stock of *corks*, of good quality and various sizes, should be kept, especially of those sizes which fit your flasks. A set of *cork-borers* (Fig. 17) should also be procured, so that holes can be bored in the corks when necessary. The borer is a metal cylinder with one end sharpened; in using it, hold the cork in the left hand and force the borer through it with a twisting motion: but do not exert too much pressure, and take care to make the hole straight and even. Leaky apparatus

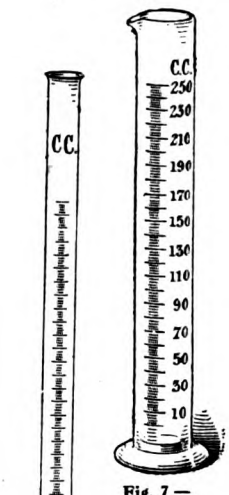


Fig. 7.—Measuring Jar.

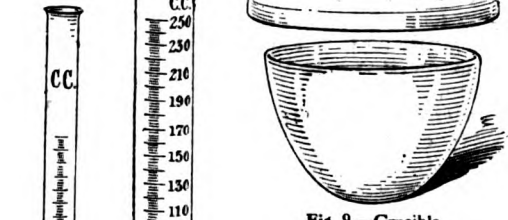


Fig. 9.—Crucible.

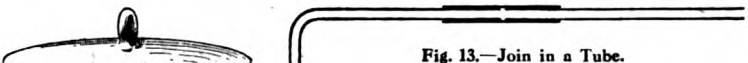


Fig. 13.—Join in a Tube.

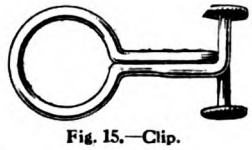


Fig. 15.—Clip.

Fig. 10.—Evaporating Basin.

Fig. 14.—Tripod.

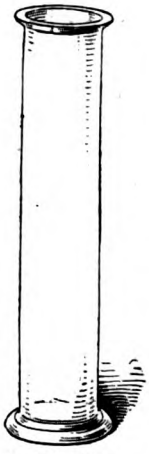


Fig. 16.—Gas Jar.

Fig. 17.—Cork Borers.

Fig. 6.—Burette.

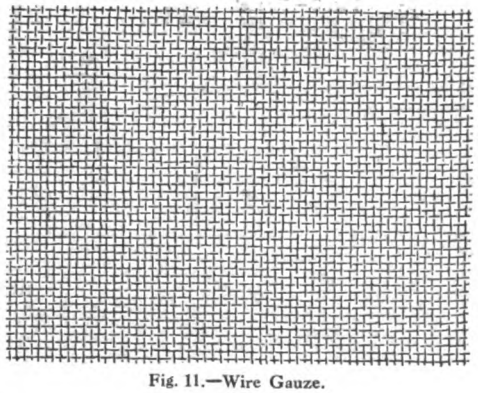


Fig. 11.—Wire Gauze.

Fig. 18.—Thermometers.

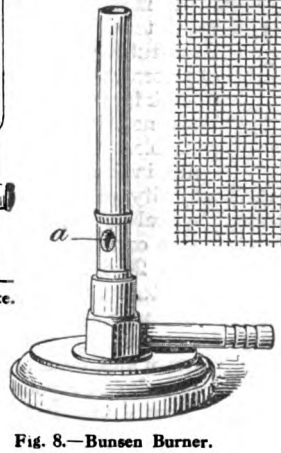


Fig. 8.—Bunsen Burner.

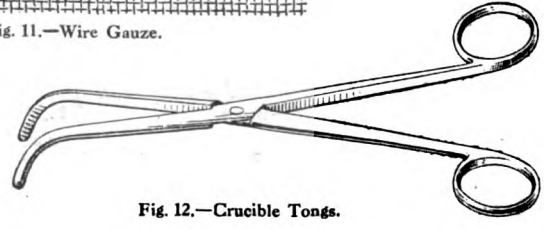


Fig. 12.—Crucible Tongs.

often results from bad cork-boring.

The *gas jar* (Fig. 16) is a glass cylinder about 10 in. high, chiefly used for collecting gases in chemical experiments. Its use in this work, along with the pneumatic trough, will be described in the lessons on Chemistry; two or three should be bought for general use, together with a few ground glass covers.

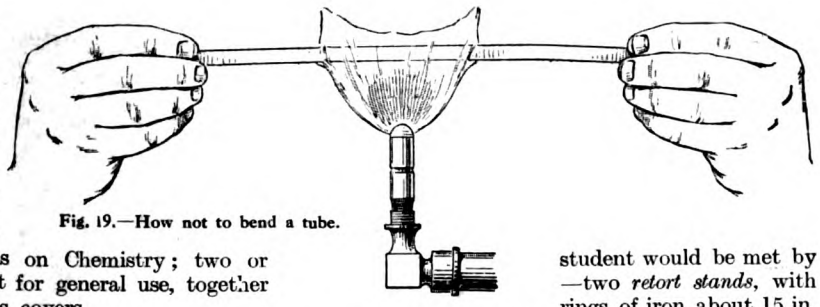


Fig. 19.—How not to bend a tube.

Other apparatus of general use includes the *porcelain basin* (3 in. and 4 in. in diameter) for evaporations (Fig. 10); the *porcelain crucible* (1½ in. and 2 in. in diameter) for strongly heating solid substances (Fig. 9); *clips* for closing an india-rubber tube (Fig. 15); and a pair of *crucible tongs* for removing hot crucibles or the like (Fig. 12).

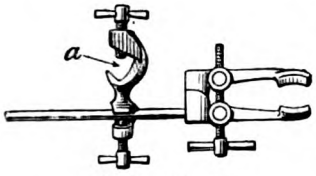


Fig. 20.—Clamp.

For the special apparatus required in particular experiments—e.g. blowpipes, pipettes, desiccators, filter pumps, etc.—reference must be made to the catalogues of dealers in scientific apparatus.

2. Heating and Supporting Apparatus.—Glass vessels, with the exception of test-tubes, should not be heated with the naked flame, but protected by a square of *wire gauze*, 5 in. by 5 in. (Fig. 11).

The heat is most conveniently obtained from the non-luminous flame of the *Bunsen burner* (Fig. 8), connected to the gas supply by a length of rubber tubing; at least two yards of this should be bought at the same time as the burner.

In order that proper attention may be given to the work of an experiment, the apparatus used must be firmly supported; for this purpose convenient stands have been devised. The requirements of the private student would be met by —two *retort stands*, with rings, of iron, about 15 in. high (Fig. 21); two brass *clamps*, of moderate size, to fit on the stands (Fig. 20); and two iron *tripods*, 7 in. in height (Fig. 14). One dozen pipe-clay *triangles* are also useful for supporting porcelain crucibles and basins (Fig. 23).

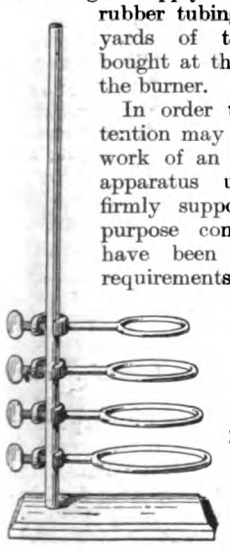


Fig. 21.—Retort Stand.

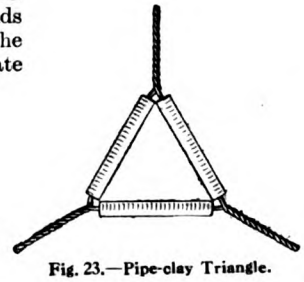


Fig. 23.—Pipe-clay Triangle.

3. Measuring Apparatus.—In scientific work the metric system is used exclusively, and from the first the student must accustom himself to thinking in metrical units.

Lengths are measured in centimetres or millimetres, and a good boxwood metre rule, divided into millimetres, is essential. Where possible, use the scale as indicated in Fig. 27, rather than measure from the end of the ruler.

Volumes are measured always in cubic centimetres. The indispensable requisite is a 100 cubic-centimetre measur-

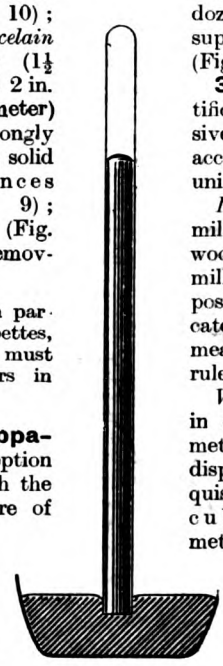


Fig. 22.—Barometer.

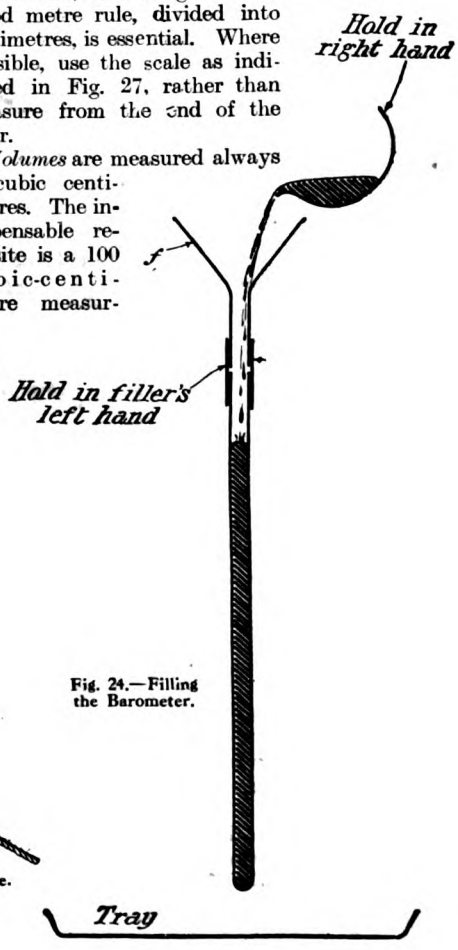


Fig. 24.—Filling the Barometer.

ing-glass, graduated to cubic centimetres (Fig. 7). For delicate work the *burette* is used (Fig. 6).

4. Balance and Weights. — The basis of Chemistry and Physics is found in accurate weighing; the student should make careful quantitative work wherever possible. For this he will need a reasonably accurate *balance* and a *set of weights* (Fig. 26).

For the work of beginners, a balance that will carry about 200 grams and weigh correctly to 1 milligram (·001 gram) is sufficiently delicate (Fig. 25). Cheap balances are not economical in the end. The box of weights must contain the following weights: 100 grams, 50, 20, 20, 10, 5, 2, 2, 1, ·5, ·2, ·2, ·1, ·05, ·02, ·02, ·01, ·005, ·002, ·002, ·001 gram. With these weights, any weight up to 200 grams can be obtained to the nearest milligram.

In order to weigh an object, place it in the left-hand scale-pan and then try a weight which you judge to be too great. Return this to the box, and try in succession each weight below this, *omitting none*; replace those which are too heavy, but retain all the others in the pan. Having obtained a balance, add the weights together, and check the result as the weights are returned to the box. Thus, if we have in the right-hand pan the following weights: 20, 5, 2, 1, ·2, ·2, ·05, ·002, ·001, the weight of the object will be 28·453 grams.

When using the balance, the following rules should be observed, partly for the benefit of the balance, and partly to save time:—

1. Do not add weights while the pans are swinging.
2. When a weight has been added, raise the handle so that the pans can swing freely, and notice the motion of the pointer, which is always towards the lighter pan. Having decided, let the handle down carefully so that the pans are supported, and remove the last weight added, or add the next one from the box, as required.
3. Before commencing a weighing, adjust the screws on which the balance rests, so that it stands horizontally; this can be tested by the little plumb-bob attached to the balance. Examine the scale-pans to see if they hang properly from their triangular supports. Take care that the scale-pans are kept quite clean, and the whole balance free from dust. The accuracy of a weighing depends entirely on attention to these small points.
4. Always use the forceps to the weights; do not touch them with the finger.
5. Perform your weighing where there is no draught; and keep the balance away from injurious acid fumes.

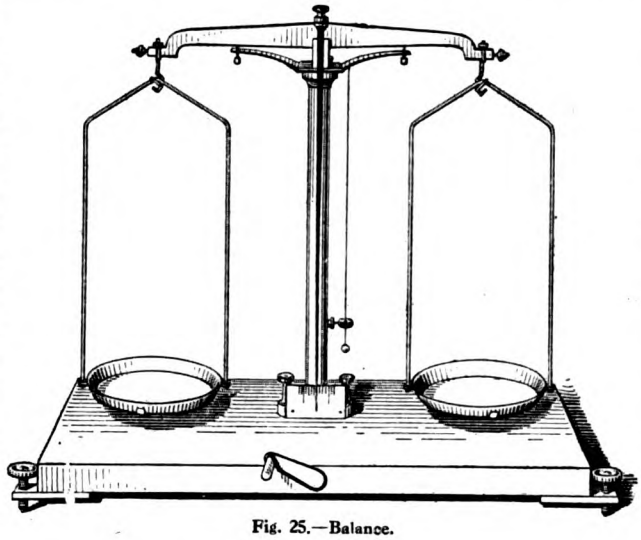


Fig. 25.—Balance.

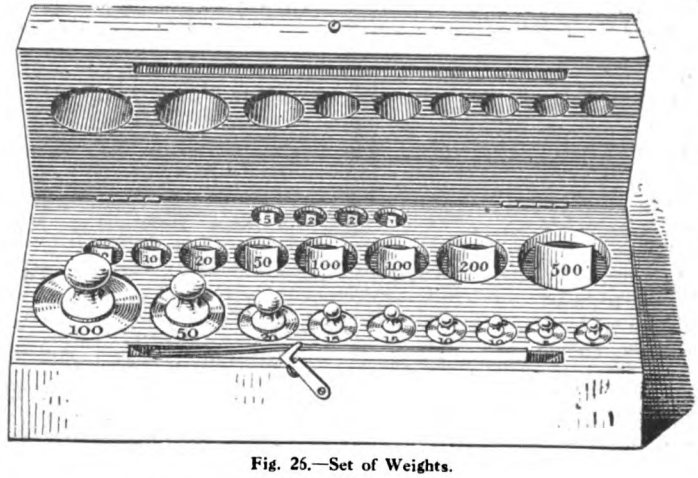


Fig. 25.—Set of Weights.

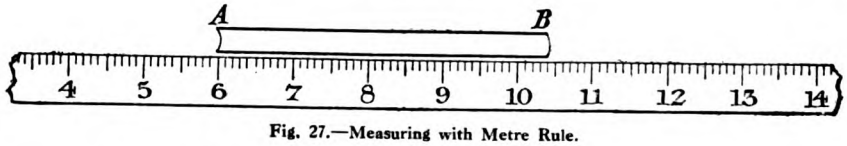


Fig. 27.—Measuring with Metre Rule.

5. The Barometer.—For many purposes it is necessary to know the height of the barometer; and if a good instrument is not available, the private student can set up a simple form for himself as follows:—

Obtain a thick-walled barometer tube, i.e. a straight glass tube, closed at one end, and

about two feet long. Fill the tube completely with mercury; close the open end with the thumb, and invert the tube, with the thumb under the surface of a reservoir of mercury in a porcelain basin. Remove the thumb without allowing air to enter the tube. The mercury in the tube will then fall, so as to stand about 75 cm. above the level of the mercury in the basin (Fig. 22). The 75 cm. of mercury are supported in position by the pressure of the atmosphere. Hence, if we measure carefully the difference in level, we obtain a measure of this pressure, in the units usually adopted, i.e. in cm. or mm. of mercury.

Mercury (2 lbs. are required) is an expensive substance, and very apt to slip wastefully away. In filling the barometer, therefore, take the precaution suggested in Fig. 24, and hold the tube over a tray, so that any mercury that may be spilt may be recovered.

Household barometers are usually graduated in inches; these should be changed into centimetres (100 cm. = 39·37 inches). Care should be taken to check the readings of such barometers, as they are apt to be very inaccurately graduated.

E. W. E.

CHEMISTRY.—I

Alchemy.—The origin of Chemistry has been traced as far back as the dawn of the Christian era. A manuscript found on an Egyptian mummy belonging to the second or third century after Christ shows that the ancient Egyptians were skilled in the use of many metals, that they knew how to make imitation noble metals (gold and silver) by the clever admixture of the less valuable or base metals, and that they had tests to distinguish the spurious noble metals from the real ones.

It was this knowledge which probably led to the belief, called Transmutation or Alchemy, that noble metals could actually be made from base metals, and thereafter for many centuries the chief aim of scientific workers was to effect such transmutations. They hoped to bring about "the great work" by the aid of the Philosopher's Stone, a hypothetical substance to which were attributed many other marvellous powers. Although this aspiration was never realised, the labours of the alchemists were in so far fruitful that they led to the discovery of many new materials, new processes, and new apparatus.

The observations of the alchemists were too frequently superficial and lacking in exactness. They neglected measurement, particularly weighing, and they suffered from what Pasteur called the greatest infirmity of the human mind—they believed a thing because they wished it to be true.

Alchemy took an unconscionable time dying; it was not until the beginning of the eighteenth century that its practice and influence began to wane, and even in the succeeding century men of ability and learning were still found who adhered to this chimerical doctrine.

In recent years experimental research on Radium has suggested that perhaps the alchemists of old were not so entirely wrong as at one time seemed certain. Reliable evidence has been furnished of the spontaneous conversion of certain metallic substances into others, but so far only transmutations of heavy into light metals have been notified, whereas the alchemistic doctrine implies the reverse process, the base metals being lighter than the noble ones; moreover, no means is known whereby such natural transmutations can be influenced by human agency.

No scientific man will assert that alchemy, as originally conceived, is impossible, for the possibilities of Nature are infinite; but in the absence of definite evidence he will continue to view it in the same light as he regards astrology, witchcraft and similar creeds.

Utility of Chemistry.—From the very earliest times the labours of chemists brought about enlightenment and improvements in the arts and industries. Not only did the knowledge of metals increase by the alchemistic strivings, but glass, pottery, soaps, dyes and medicines all received attention. At the present time there is scarcely a trade, industry, art or science into which Chemistry does not enter, directly or indirectly. Agriculture, metallurgy, fuels, lighting, textiles, oils, tanning, sanitation, paints, ceramics, drugs, dyes and explosives, are but a few of the many spheres into which the science has successfully penetrated; and if the future course of civilisation proceeds on the lines of the past, the need for the chemist is far more likely to increase than diminish.

It is not only from a "bread and butter" point of view that Chemistry has justified its study and practice. This science is a most valuable educational implement. It not only stimulates interest, develops hand and eye and informs the mind, but, even more important than these, it inculcates the habits of correct observation and of sound reasoning, the indispensable conditions of success in all spheres of life.

"All is Change."—One of the most elementary and most striking of all truths is that the world around us is in a state of ceaseless change.

The air we breathe becomes noticeably altered where human beings are confined in a restricted space; the water we drink is changed by boiling, becoming less palatable to the taste and "softer" for washing purposes; the fires we burn effect radical changes in the foodstuffs we cook upon them. The very earth we live upon is a phantasmagoria of unrest.

The exact study of material substances and of the changes they undergo is the subject-matter of Natural Science. Since these changes are so immense in number, and often so diverse in kind, Natural Science is subdivided into a number of special sciences, in each of which similar changes are grouped together. Chemistry is one of these subdivisions. Such classifications are made by man for the sake of his convenience; there are no sharply-defined boundaries in Nature.

Our first task will be to consider some of the common changes we observe in everyday life, and to endeavour to classify them.

Physical and Chemical Changes.—The filament of an electric lamp gives out light and heat

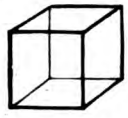
so long as the current passes through it, but when the latter is switched off the filament is found to be in no way altered, its weight and other properties are exactly the same as before. A pound of liquid water on being boiled will give exactly a pound of gaseous steam, or on being frozen a pound of solid ice, and vice versa in each case. Water, steam and ice are forms of the same substance, and their transformations are caused by the inflow or outflow of heat.

The above are known as "physical" changes; they are temporary, persisting only so long as the exciting cause is active: the composition of the substance undergoing the change is unaffected. On the other hand, when wood is put on a fire it not only gets hot and emits light (physical changes), but it disappears, giving rise to entirely new substances—colourless gases and incombustible ashes.

Iron exposed to moist air becomes coated with a layer of rust, an entirely different substance from the metal iron. An acid, like vinegar, and certain microbes turn milk permanently sour; heat profoundly alters the nature of an egg.

1 centimetre.

1 square centimetre.


1 cubic centimetre.

The phenomena of life—germination, birth, growth, decay, death and putrefaction all involve permanent changes of a deep-seated kind. Such changes are called "chemical," and they are always accompanied by a change in composition. Chemistry, then, is that branch of Natural Science which deals with those changes which involve an alteration in composition. Chemical changes are almost invariably accompanied by physical changes: hence the sister sciences of Chemistry and Physics are closely inter-related, and the chemical student can make but little headway unless he has some elementary knowledge of Heat, Mechanics, Hydrostatics, and Electricity at his command.

Further, since science is *exact* knowledge, the student cannot proceed far unless he is capable of applying some elementary mathematics. It is probably going too far to state that "science is measurement," but it is undoubtedly true that the application of mathematics to a science is of the very greatest utility, and the greater the extent of its application the more exact is the science.

Measurement. The Metric System.—The fundamental unit of length employed in all scientific work is the *metre*, which is defined as the length of a certain rod of platinum kept in Paris. This length is equivalent to 39·37 inches. It is subdivided into ten, one hundred, and one thousand parts, which are called respectively the *decimetre*, the *centimetre* (cm.), and the *millimetre* (mm.). A glance at a metre- or half-metre-rule will at once give an idea of their lengths. The student should make himself familiar with them at the very beginning, and he will find his burden lightened if he refers them to the dimensions of common objects; thus the width of an average finger-nail is a centimetre, and the thickness of a sixpence is a millimetre. Multiples of the metre are not often used in Chemistry; the commonest is the kilometre, 1,000 metres, equal to nearly two-thirds of a mile.

Very small lengths are expressed in terms of the micron (written μ, the Greek letter m); it is the one-thousandth part of a millimetre, and hence the millionth part of a metre. The smallest particles of matter which have been definitely detected have a diameter of 5 $\mu\mu$.

Measurements of area are expressed in terms of *square centimetres* (sq. cm.) and those of volume in *cubic centimetres* (c.c. or c.cm.). The unit of volume is a cube of which each edge is one centimetre in length. It is a very important unit. A cubic decilitre, that is a cube of 10 cm. edge, is called a *litre*; it contains 1,000 cubic centimetres, and is equivalent, roughly speaking, to about $1\frac{3}{4}$ pints.

The standard or unit of weight is the *gram*. It is defined as the weight of one cubic centimetre of pure water at a definite temperature (4° Centigrade). At this temperature the weight and the volume of any given amount of water will be expressed by the same number. Since water expands when heated above, or cooled below, the temperature chosen, the weight of a c.c. will be somewhat less than a gram at all other temperatures.

There are approximately $15\frac{1}{2}$ grains in a gram, and $28\frac{1}{3}$ grams in an ounce avoirdupois. Multiples and sub-multiples of the gram are expressed in a similar manner to those of the units of length, area and volume, thus 1,000 grams is called a kilogram ($= 2\frac{1}{5}$ lbs. avoir.), ·1 gm. is a decigram, ·01 a centigram, and ·001 g. a milligram. With a really good balance it is possible to weigh accurately to the tenth part of a milligram (·0001 gm.), but for elementary work a balance that turns to 2 mg. is sufficiently accurate for nearly all purposes.

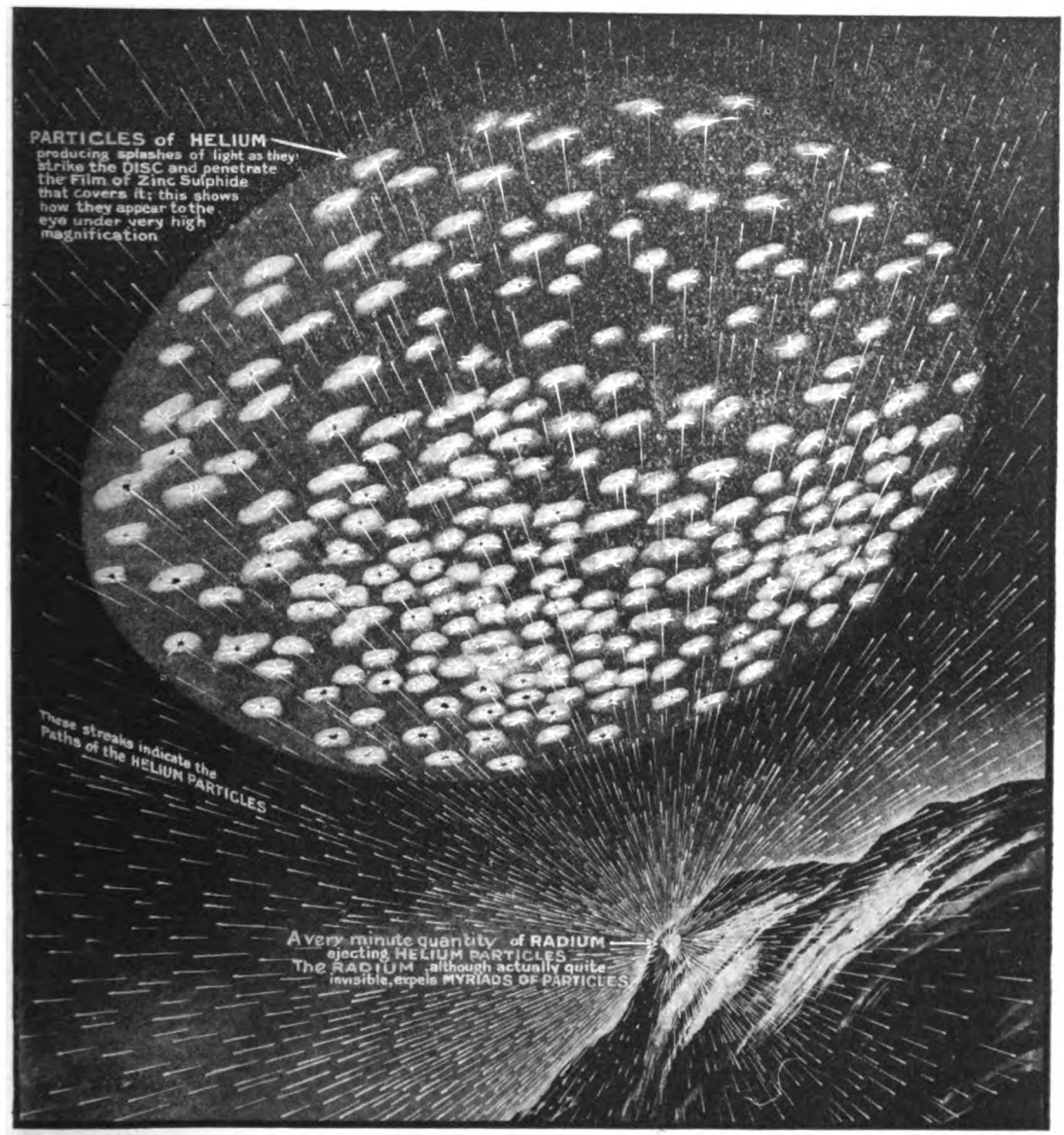
It will thus be seen that the Metric System is a decimal system, and that very simple relations obtain between the standards of length, area, volume and weight. An enormous amount of labour in making calculations is saved by its use. In scientific work the employment of this system is nowadays universal.

Equivalents of English and Metric Measures

1 oz. avoir.	= 28·35 gm.
1 lb. avoir.	= 453·59 gm.
1 inch	= 2·54 cm.
1 foot	= 30·48 cm.
1 pint	= 568 c.c. or 0·568 litres.
1 gallon	= 4·546 litres.
1 gram	= ·035 oz. = 15·43 grains.
1 kilogram	= 2·20 lb.
1 metre	= 39·37 inches.
1 centimetre	= ·39 or $\frac{2}{5}$ inch.
1 c.c.	= ·061 cubic inch.
1 litre	= 61·03 cub. inch = 1·76 pints = ·22 gallon.

The Balance.—Of all the instruments of precision that are used by the chemist, the balance is by far the most important. What the telescope is to the astronomer, and the compass to the mariner, that is the balance to the chemist.

The early efforts of the alchemists and other seekers after natural knowledge often missed their aim owing to the neglect of this instrument, and perhaps the greatest revolution which the science of Chemistry has experienced—the discovery of the nature of combustion by Lavoisier towards the end of the eighteenth century—was the direct outcome of its systematic employment. It is, therefore, with a feeling akin to veneration that the experienced chemist uses his balance to guide him at every step, and the beginner must follow his example and always bear in mind that this delicate apparatus and its accompanying weights must be kept and guarded with a zealous care,



"ALL IS CHANGE."

A remarkable drawing demonstrating this elementary truth. By means of a spinthariscope, an instrument fitted with a very powerful lens and a disc covered with zinc sulphide, it is possible to see (as above) particles of helium escaping from radium.

and so maintained in a state of the strictest cleanliness and efficiency.

The most important of all lessons for the budding scientist is to understand this "open sesame" to accurate knowledge. The type of balance used in elementary work is made of brass, and consists essentially of a horizontal beam supported on a vertical pillar. The beam carries three knife-edges of agate or steel, one placed in the centre and supported on agate planes situated at the top of the pillar, and the other two at its extremities, supporting the stirrups and pans.

In order to equalise the weights of the two sides of the beam, small adjustable weights running on screws are fixed at the ends. The beam is set in motion by means of a handle or lever placed at the base of the pillar, and its motion is indicated by a long thin metallic pointer attached to its centre, the other extremity moving over a graduated scale. When the sides of the balance are in equilibrium, this pointer moves to an equal distance each side of the middle point or zero of the scale.

The pillar is usually provided with a plumb-line so that its vertical position may be secured, any alterations of level being made by adjusting the screws upon which the wooden base of the balance rests. It is advisable to keep the balance inside a case of wood and glass, and to prevent the metal parts from tarnishing a small vessel containing calcium chloride or soda-lime should be present.

The weights are kept in a special box, and they must only be manipulated by means of the forceps supplied. The larger weights, made of brass, are numbered 100, 50, 20, 20, 10, 5, 2, 2, and 1 gram; the fractions of a gram, usually cut out of sheet aluminium or german silver, are marked in milligrams as follows: 500, 200, 200, 100, 50, 20, 20, 10, 5, 2, 2, 1. To obtain the equivalent weights in grams it is only necessary to divide each weight by 1,000, thus 200 mg. is 0·2 gram.

In the operation of weighing it is recommended to place the weights on the balance pan in the same relative positions as they are present in the box—the largest weight used being put in the centre. Before weighing it must be seen that the plumb-line is vertical and that the pointer swings equally to each side of the scale when the pans are empty. The object to be weighed is placed on the left-hand pan, and the weights on the right. The latter should be chosen systematically, beginning with the largest.

A most important rule is not to put anything on, or take anything off, the pans, while the beam is in motion. No object should be weighed which is hot or warmer than the balance and the surrounding air, and only clean and dry apparatus and clean metals should be weighed directly on the balance pan; all other substances must be weighed out on or in vessels of glass or porcelain.

Chemistry is essentially a *practical* science and little progress can be made in learning it unless the hand and the eye are made the constant and willing servants of the mind. The only method of studying it successfully is summed up in the words "experiment, observation, inference," which is the identical method of the scout and of the detective.

E. H. T.

ZOOLOGY.—I

We know that every member of animate creation descends from parents like itself. Man and mollusc are the offspring respectively of man and mollusc.

This is not to say that the many forms in which life presents itself to-day have always existed. Nature is the greatest of pioneers, ever thrusting on into the unknown, advancing by devious courses, elaborating long-continued developments in this direction and that, often in the end, to sacrifice them; endowing some forms of life with colossal bulk, or tremendous force of weapons, incredible defences of plate and mail and bone, then flinging them aside and permitting their type to become extinct, like a creator of fashions in clothes who kills a vogue in costume as soon as it is established, in order to secure profit from another.

Many as are the life forms with which the student of Nature is familiar to-day, these are few in number compared with those that have perished. The crust of the earth is a charnel-house compact of the bones of Nature's past experiments. Mired in frozen marsh, embosomed in what has now become rocks, is written the chapter of her failures.

"Giants in the Earth"

Nature has preserved the whale and the elephant, the giraffe and the rhinoceros, the seal elephant and the drowsy dugong; but she has sacrificed the mammoth and the mastodon; she has flung into her earth-wide sepulchre the appalling dinosaurs, the diplodocus and the towering, fantastic gigantosaur; the glyptodon in its fortress of mail, the fishes that laboured in the waters accoutred like animate dreadnoughts.

Why have these monsters run their race and perished from off the face of the earth?

No man knows, but several possible causes may have been operative. Undoubtedly one of them is, that Nature began late the task of building brains. She conceded bulk, strength, fertility, but the brains of the giants that once possessed the earth were contemptible—contemptible in bulk, contemptible in quality. From age to age large forms of animal life inherited a tendency to grow greater in size of body, not of brain. There is an inherent impulse in all living creatures towards specialisation.

The animal which most swiftly adapts itself by special means to environment must necessarily succeed above its fellows. But characteristics highly developed in one direction availing for given conditions,

may prove harmful when the conditions change. A giraffe is highly specialised, in respect of its exceptionally long neck, for browsing upon the foliage of the high-pitched crowns of the acacia; the great ant-eater, with its long, cylindrical mouth and extensile tongue is equally well adapted for a diet of insects. But, set a giraffe in a treeless pasture, and limit the food of the ant-eater to that given to a dog, and we should see at once the evils attendant upon excessive specialisation. Giraffe and ant-eater would perish of starvation.

Brains v. Bulk

Bulk was a specialisation of the monsters whose dead, dry bones fill Nature's lumber room. It must have offered advantages; for the time being, size spelled success.

Many orders survive to-day which have had giants among their ancestors. But the smaller varieties, which did not so greatly specialise as to size, eventually won the day. The active among Nature's children, the alert and cunning, those which have combined speed with strength and initiative with both, those which have developed communal habits, and in some sort taken thought for the morrow.

Many and marvellous are the shifts for a living to which members of the great animal family resort. Birds, the descendants of reptiles, have converted their fore-legs into wings, their scales into feathers. Insect-eating mammals have taken unto themselves leathery wings with which to fly as bats. Whales have surrendered the legs with which they once trod the land, and betaken themselves to the deeps; snakes have sloughed their feet in order to writhe, crawl and swim. Hedgehog, tortoise and turtle, like the porcupine and pangolin, look to armour for defence of life; the camel, with his specialised stomach, crosses the desert without dread of drought.

Animal Architects

We find among the lower animals architects and engineers, whose work is an abiding challenge to the imagination of the cultured yet unmechanical scholar; insects whose cities, for wonder of design and perfection of hygienic and sanitary detail, are immeasurably in advance of any corresponding effort on the part of highly civilised man. We have birds that sew and weave, the first of textile artisans; we have fish that build nests, insects that ensnare with pitfall and gin.

Vastly complex and closely interrelated is the scheme of life of which mankind is the head and crown.

The bulk of living animals fall into two classes, in the matter of diet—those which are herbivorous and those which are carnivorous. The omnivorous throw their weight alternately into each scale. And the plain law seems to be that those which eat herbs shall serve to feed those that need flesh. The herbivore builds up bone, blood and muscle from the grain and herbage of earth; the carnivore gets the result when it devours the herbivore. Hence all life depends upon the products of the earth, for without herbage the herbivores would perish, and without herbivores the flesh-eaters in turn would cease to exist.

The varying results attained from limited types of food-supply are in themselves among the miracles of Nature. The same substances which endow the timid rabbit with fur and fears, build up the mighty structure, the fine stamina, the intelligence and speed of the war horse. The same food over which the frog contentedly croaks sustains the life of the nightingale with his heart-stirring song.

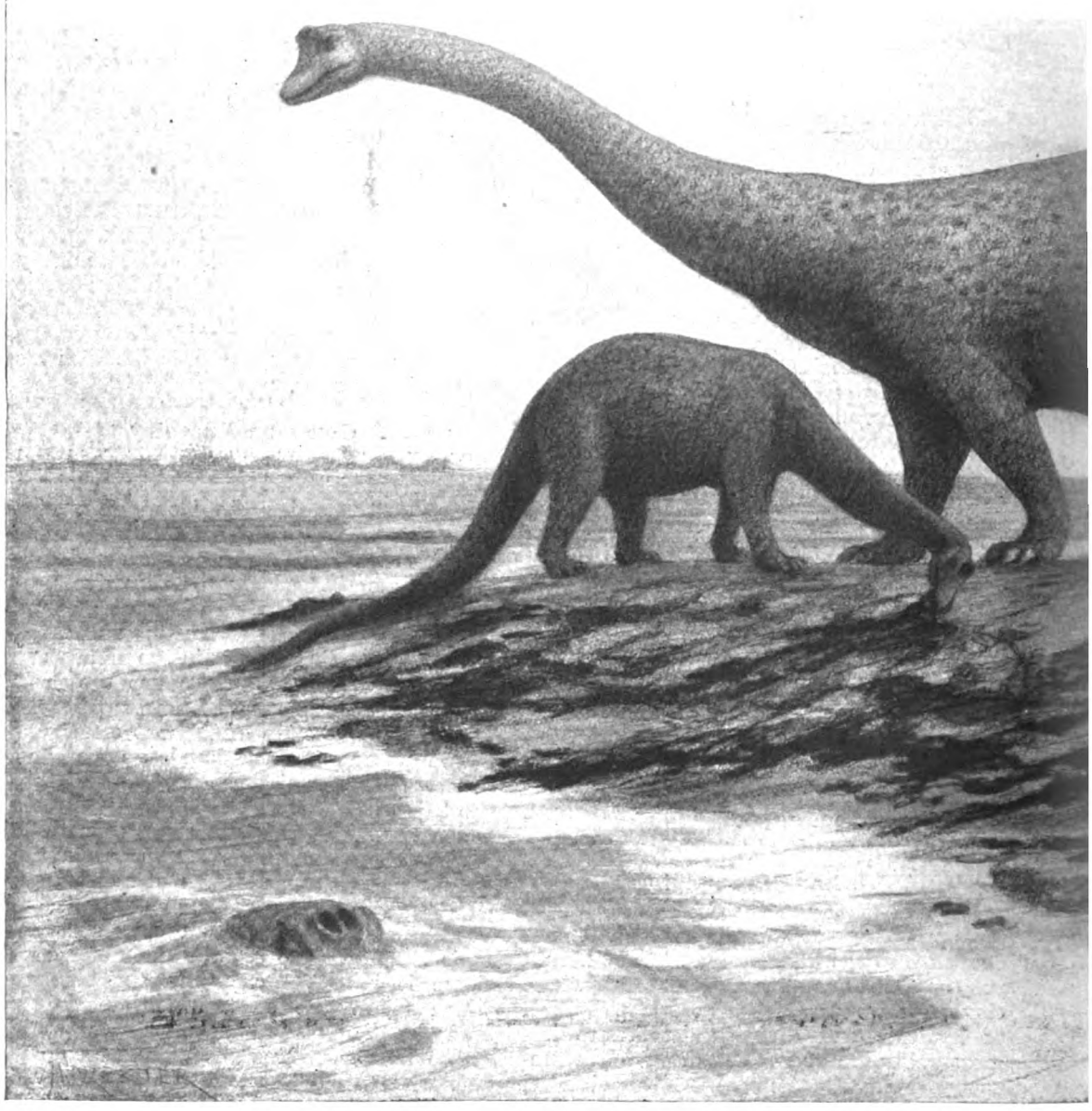
A Common Ancestry

The lizard eats his fill of insect food and remains cold-blooded and inert; precisely similar diet sustains the blood of a bird at a temperature which in human veins would mean high fever and swift death. Insects, metabolised by the digestive processes of the lizard, yield him scales, claws, horny jaws and frigid blood; submitted to a corresponding process in the alimentary system of a bird, they produce the most gorgeous feathers, and yield powers of flight and song unmatched throughout creation.

The grass of the field builds up the bony fortress of the tortoise, the wool of the sheep, the hair of the horse, the branching antlers which the deer grows and sheds each year.

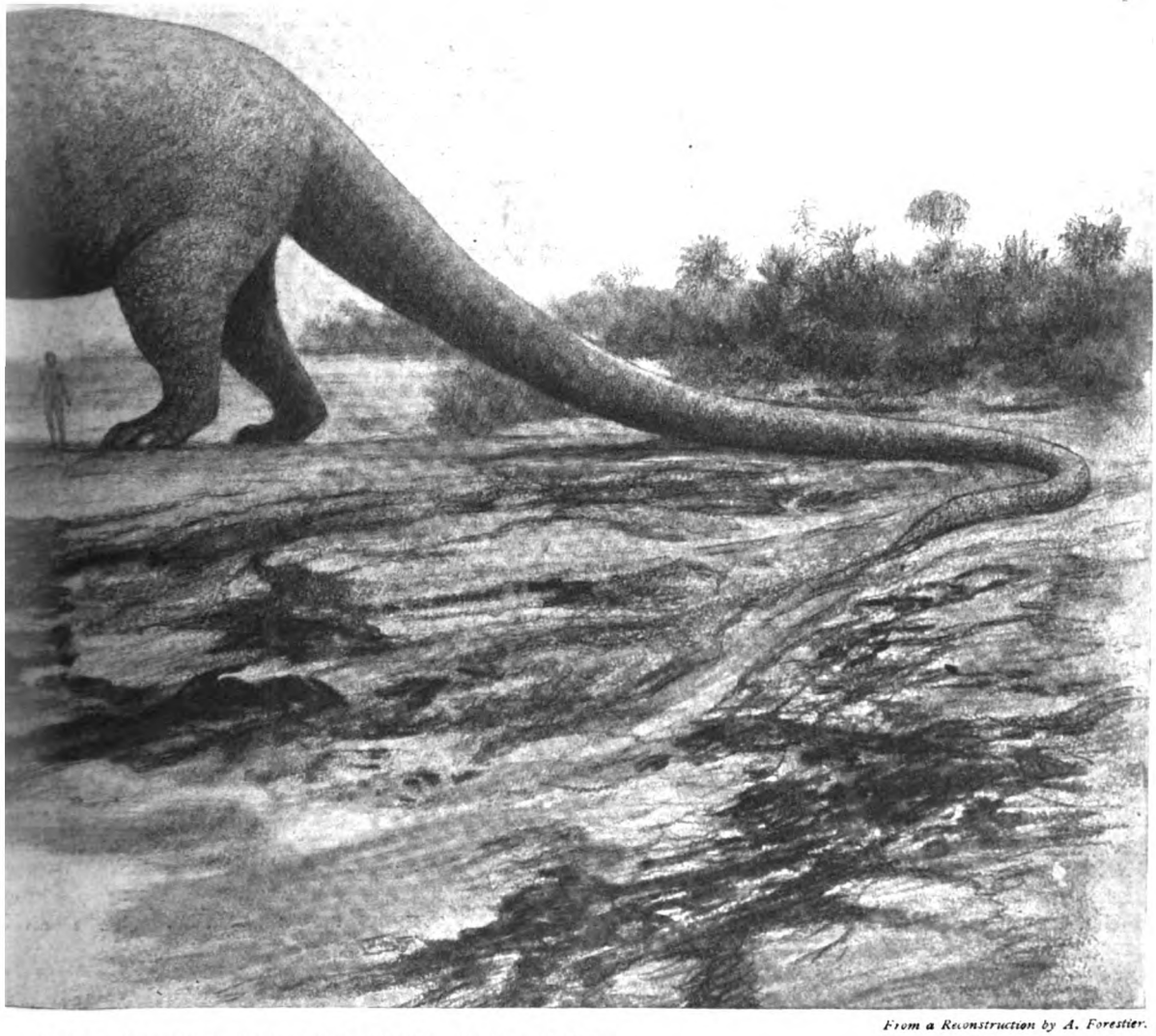
The cobra unconsciously concocts its deadly venom from the flesh of non-poisonous animals, while sea-snakes, the most virulently poisonous of all snakes, distil their lethal juices from the flesh of fishes. There is infinite mystery in the changes which follow the consumption of similar foods by dissimilar animals.

The mystery seems the more unfathomable when we reflect that all life descends from a common ancestry. As every student knows, life began in the waters. We do not know in what primitive guise it first appeared. There exist to-day unthinkable hosts of life-forms, so simple that we call



THE GIGANTOSAURUS AFRICANUS—PROBABLY

An almost complete skeleton of this land dragon, which measured 160 feet in length, was discovered not long
animals specialized in bulk. The monster contrasted above with a man and diplodocus had a brain cavity



From a Reconstruction by A. Forestier.

THE LARGEST MONSTER THAT EVER LIVED.

before the Great War, in what was then German East Africa. Nature was late in inventing brains. Primitive which would hardly hold a child's fist. Incidentally, he was a vegetarian; this is shown by his teeth.

them protozoa, implying our view that they are the first or most primitive of life forms. They are simply animated specks of jelly, each consisting of a single cell. All the essential processes of life run their course within the structure of this tiny organism. The protozoon absorbs nourishment, it grows, it reproduces its kind. That protozoon is the animal world in miniature.

All life, the life of a man, the life of a mouse, the life of an elephant, the life of a whale, proceeds from a single cell, a single structural unit. The man who is destined to sway senates, to command armies, to write a deathless poem, begins his career, as the career of a starfish is begun, in this single tiny structural unit; and the first stages of the development of all are precisely similar.

Masses of Protoplasm

The life history of a species or order is written in the life history of the embryo within the egg, and in the stages which lead on to complete development. Not all the chapters can be traced, for with the passing of unnumbered ages stages of development have been slowly obliterated; but the essential record remains.

In tracing the development of the frog from the egg to the tadpole, from the tadpole to the adult animal, we gain a picture of the phases by which this amphibian arose from lowlier planes of life. Each stage that we now follow in the course of its growth from egg to fish-like larva, drowning in open air, through the strange loss of gills and formation of lungs, so that in time, if confined to water, it drowns there for want of atmospheric air—each stage represents to us a definite form and habit of frog life in times past, each condition is a fingerpost marking the goal which bygone frogs attained. Once they were simply single-celled masses of protoplasm; once they were restricted throughout life to existence in water, extracting oxygen for respiration by means of gills as they now extract it during the tadpole era.

Life generally developed on some such lines. All animate creation had its abode in the waters—in the seas and rivers, the seas not then as briny as is now the case, or amphibians could not have evolved, for no amphibian known to us can survive salinity in the water, hence the absence of frogs and their kind from oceanic islands. We cannot say, of course, that the protozoa known to us have the least resemblance to the lowly forms from which more highly organised life arose. But that life arose from forms no higher is beyond question.

Slowly, very slowly, life crept ashore. It was a mighty adventure.

Watch a fish in a bowl insufficiently supplied with water, thrusting his snout above the surface of the exhausted fluid to take a gulp of air from the atmosphere; watch a tadpole when he is exchanging his gills for lungs, and we get an idea of how salutary was the change that had to be undergone. Probably it began with animals becoming stranded on shore on damp sands or in meagre pools between tides. Gills for extracting oxygen from the water had to go, and a method of inspiring and pumping out air had to be substituted. Nature had to invent lungs.

New modes of locomotion had to be evolved. Fins had to be modified into flippers, and flippers into paws and feet.

Not all life came ashore. Certain fishes put on bony armour and fought it out for ages as armoured cruisers. Others retreated to the abysmal depths, where neither sunlight nor vegetation is, and where food comes with such comparative infrequency that the denizens of these depths had to develop capacity for enormous storage, enabling them to swallow victims actually greater in bulk than themselves. Others found safety in swift mobility, in ability to travel fast to feeding grounds afar, and accustomed themselves to variety of diet and to variety of conditions.

Birds and Mammals

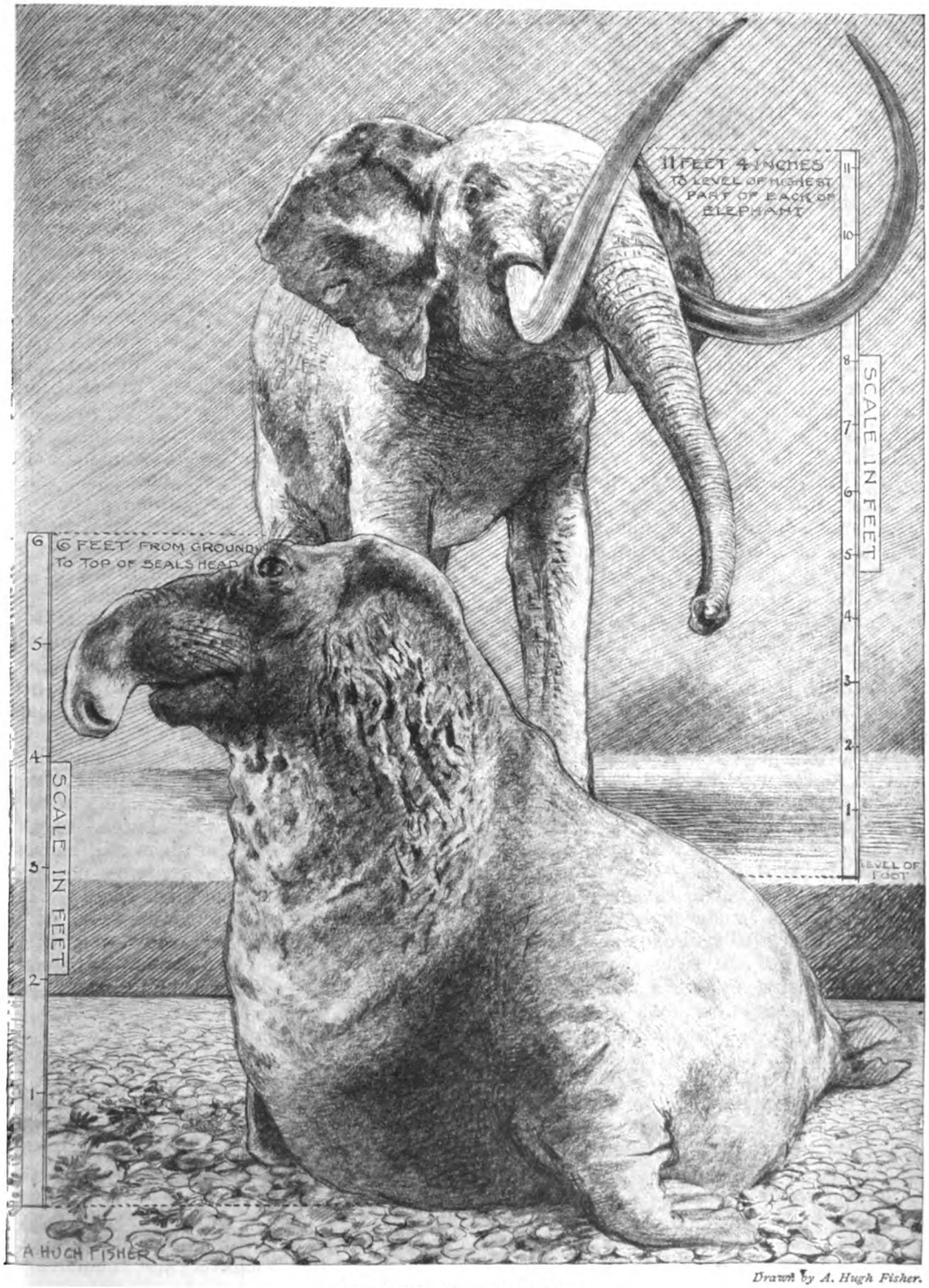
On shore life developed apace.

We must assume that the amphibians first matured. The young would naturally be hatched in the native element of their ancestors, repeating the life cycle through which these had passed. After these the reptiles, born ashore, to live for the greater part of their lives ashore, and from the reptiles and allied forms, birds and mammals, the latter the highest form.

How the change from cold blood to warm blood was effected we cannot know, any more than we can know how scales were converted into hair, and hair sacrificed in favour of the comfort and cleanliness of a smooth skin.

Insects, land-haunting insects, were early evolved, and these were the first to practise flying. Insects were probably indirectly the begetters of the wings of reptiles and birds. These creatures would need better means than legs and feet with which to catch winged prey.

Brains came with the mammals. The



Drawn by A. Hugh Fisher.

GIANTS OF TO-DAY.

An African elephant compared with an elephant-seal, the bulkiest—with the exception of the whale—of existing sea animals. The trunk of the elephant-seal, though it does not attain the size of an elephant's, is none the less apparent.

first mammals—warm-blooded animals which suckle their young, be they dolphins, whales, elephants, dormice or human beings—the first mammals brought forth the necessity for greater brain power. They appeared in the scheme of life when monsters ruled the earth. They were small and insignificant, and liable without the exercise of acute intelligence to be snapped out of existence by carnivorous dinosaurs or other terrors of the twilight earth. Their young were born immature and helpless, and so needed care and sustenance from the parent. Mother-love was born into the world with the first mammals, and mother-love was accompanied by mother-wit.

The mammals, as the most intelligent type, were destined soon to become a new and far-reaching dynasty; the lumbering mass and powers of the giants availed not to keep them alive. Slowly the monsters died, as witless giants always die. The race remained to the mammals, who now, with man at their head, possess the earth.

E. A. B.

ASTRONOMY.—I

In this course we shall try to give some account of the science and practice of Astronomy as it affects everyday life, and as it interests the many students of it who are not professional astronomers, but find in Astronomy an engrossing diversion from everyday worries. And we will begin with the way in which—very often unknown to the dweller upon earth, or at least uncomprehended by him—his daily life is affected by the particular plan on which the Universe is constructed. One is accustomed to the usually disagreeable difference between winter and summer; one knows by report, if not by experience, of the way that the sun and the moon behave in the Tropics, or in the Southern Hemisphere, differently from the way that they behave in England; but it is probable that a great many people would find it hard to explain precisely what that difference was.

One is used to the fact that the time of this country comes from the Royal Observatory at Greenwich and the time in other countries is different. One finds by experiment that the sundial does not always give the right time. One knows that the harvest moon in the autumn rises very nearly at the same time night after night; while the moon in the spring, under other circumstances, rises a great deal later on successive nights. It is common knowledge that the mariner finds his way from port to port by means of the sun and stars; and it is not quite so well known that the surveyor who makes maps has equally to rely upon the sun and the stars for an essential part of his results.

The why and the wherefore of all these things is not at all difficult to understand; and yet it is just sufficiently difficult to be some degrees removed from the obvious. It will be the purpose of this and the subsequent lessons to set down, as simply as possible, these facts of everyday Astronomy.

Day and Night

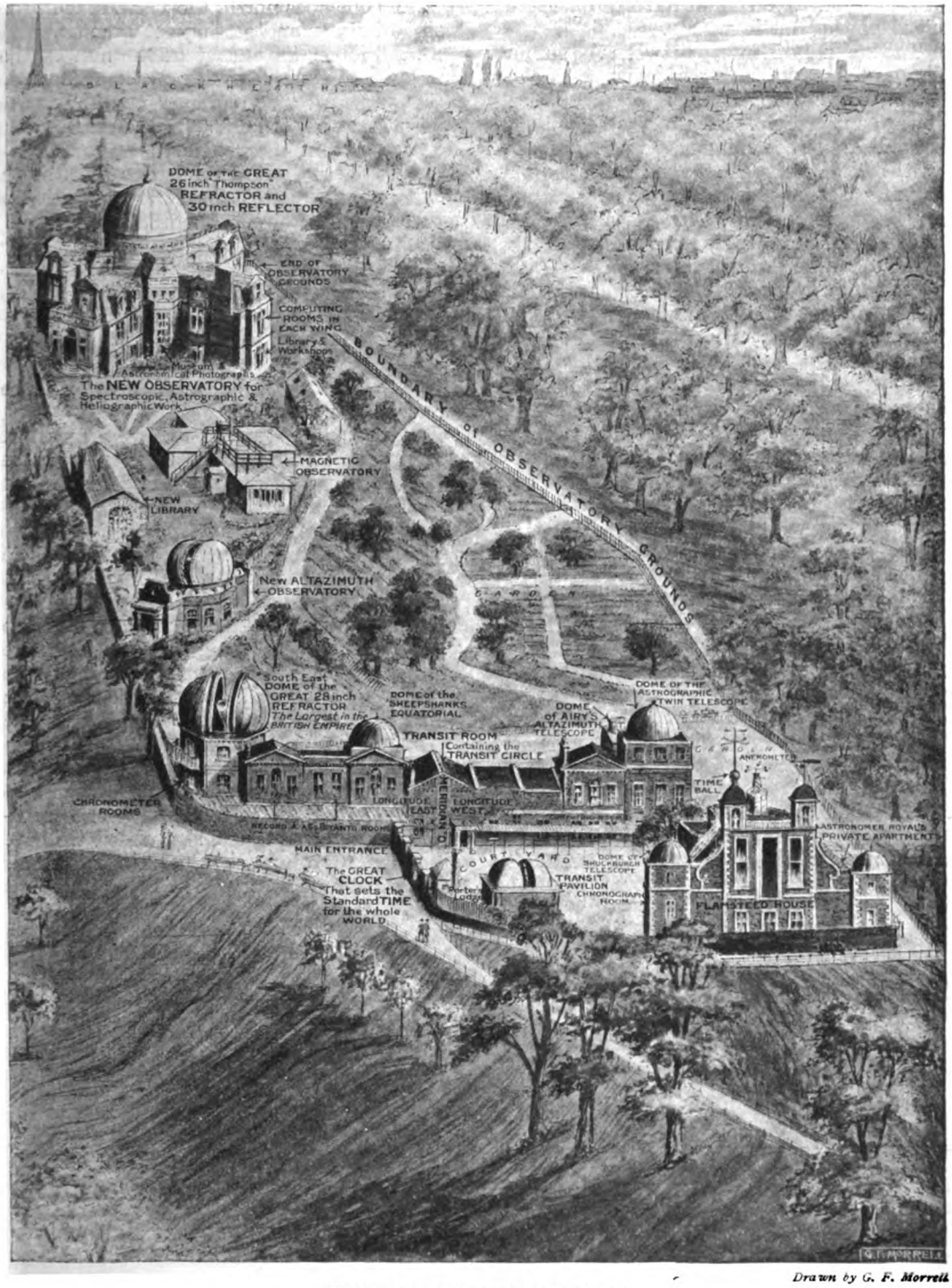
And we will try to do so without the aid of mathematics, which is, quite rightly, associated with Astronomy as an indispensable ally. The fact that we are going to do without mathematics cuts us off, of course, from immense regions of the subject; but those were not the regions which we set out to explore. We shall get on very well without mathematics in any proper sense of the term.

Let us first bring together a few of the obvious facts about day and night.

In London at midsummer the sun rises in the north-east before 4 A.M. At noon he is high on the meridian, more than 60° from the horizon; and he sets in the north-west some time after 8 P.M. At night, although the sun has set, there is still light in the sky, which travels round along the northern horizon and blots out the stars in that part of the heavens. We need go only a little farther north—say, to Edinburgh—to find the day still longer, the night still shorter, at midsummer. In the extreme north of Scotland there is no real night at all; while travellers at this time of year who go to the North Cape beyond the Arctic Circle may see the sun clear above the horizon at what is still nominally midnight.

Winter in the Arctic

On the other hand, at midwinter in London the sun rises in the south-east after 8 A.M.; at noon he is only 15° above the horizon and scarcely clears the taller buildings, so that many streets get no ray of the sun at all throughout the short day; and he sets before 4 o'clock in the south-west. If we go north again at this time of year we find conditions worse still. The night is longer, the day is shorter, and the sun rises even less high at midday. If we could go again to the North Cape we should see at what is nominally midday a kind of dawn in the south. But the sun would not appear; and in place of the perpetual day



Drawn by G. F. Morrell

THE CITY OF THE STARS.

A drawing showing the arrangement of the famous Observatory at Greenwich. The Observatory was founded by King Charles II., Flamsteed House being the original building.

of midsummer we should have the perpetual night of the Arctic winter.

The marked difference between the summer day and the winter day becomes, it is clear, more strongly marked as one goes north towards the Pole. If we went south we should find it becoming rapidly less marked. In the Mediterranean, for example, the midsummer day is not so long, the midwinter day is correspondingly longer, and both in midsummer and midwinter the sun rises higher than he does with us. If we look on a map and find that we have gone 20° south of London, we can say at once how much higher the sun rises. It is the same 20°.

Go still farther south until we come to the Equator. Here we may remark what we might have remarked to a less degree in the Mediterranean, that the sun instead of rising at a slant rises much more vertically, and the dawn and dusk are much shorter than with us in London. "At one stride comes the dark," the poet has it; which is only a poetic exaggeration for the fact that in the Tropics the sun goes very nearly straight up and down.

Sunrise and Latitude

These bare statements of fact we can now collect together in a small series of figures which, when put together, carry their explanation on their faces.

In these figures we have shown how—

1. For any one place the sun, as the year progresses from winter to summer, rises farther from the south, and crosses the meridian higher above the southern horizon.

2. As one goes north, the variations in the point of rising and setting get greater.

3. Although the height of the sun on the meridian—that is to say, the noontide height—gets less as one goes north, yet the differences of this height for different times of year remain the same.

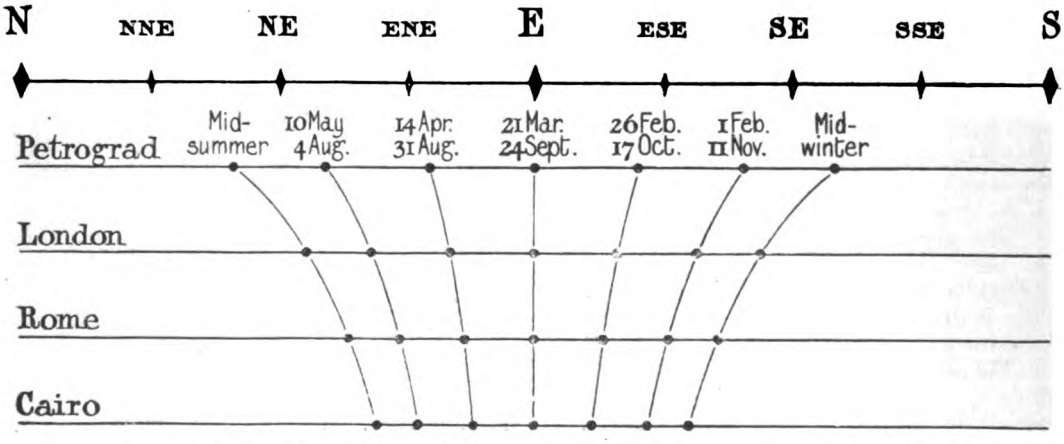
4. If, on the other hand, one goes south towards the Equator, the variation with the season of the points of sunrise and sunset become less; and the sun goes up straighter at his rising; but still the difference of noontide height for different times of the year is the same.

The Celestial Sphere

These facts can be represented in the following way:

Take a sphere turning upon an axis N.S. and mark on it three points D, M, J, of which M is half-way between north and south, and J and D are at equal distances from M towards north and south respectively. If we turn the sphere about the axis N.S., these three points D, M, and J will describe paths such as are shown by the dotted circles.

Next, suppose that inside the sphere there were a fixed plane passing through the centre C and extending to the surface, or if we like to imagine it, extending through the surface; and let us note where the circles described by D, J, and M cut this plane. We shall see at once that the movements of these points D, M, and J, with respect to an observer at C, agree in all their details with the movements of the sun in the sky which we have described for any one place. J represents the sun at midsummer, M at the equinoxes



Variation of place of Sunrise with Season and Latitude

As the year progresses from winter to summer the sun rises farther from the south, crossing the meridian higher above the southern horizon. Variations become greater the farther north one goes

in spring and autumn, D the sun at mid-winter.

Now we may go a step farther. Suppose that the axis N.S. becomes more nearly perpendicular to the plane through C; this corresponds to the conditions farther north. If, on the other hand, it is less inclined to the plane, our circles, representing the paths of the sun in the sky, rise above the plane at points less widely separated, and rise straighter up. We shall note that with the variation of the inclination of N.S. to the plane, the points of rising and setting shift in position very much; but the circles maintain their distances apart unchanged.

Now, if we are to consider this figure as representing the motion of the sun in the sky, we have to imagine the earth as shrunk to a tiny point at C, of a size infinitesimally small compared with the sphere of the sun; and in this case the fixed plane through C represents the plane of the horizon of the supposed observer.

For some reason or other, there are many people who find it difficult to visualise these attempts at drawing a solid sphere upon a flat sheet of paper. They will probably find it helpful if they take an ordinary terrestrial globe, made so that the inclination of the axis upon which the globe turns can be varied with respect to the rim which represents the horizon; and with a globe like this one can study the effect upon the point of rising, and upon the noontide height, of the varying position of the sun with respect to the Equator, or of the poles of rotation with respect to the horizon.

Further, on many of these terrestrial globes there is drawn a mysterious circle cutting the Equator at an angle of 23°, which is labelled the Ecliptic. It is always a puzzle why this circle should be drawn upon a globe of the earth. But it does serve a useful purpose in studying the motions of the sun and the stars with respect to the horizon, if, as we propose now to do, we turn in imagination our terrestrial globe into a celestial.

Imagination will necessarily play a large part in the business, for, of course, there is no such thing as an actual celestial globe. The stars are scattered through space at very varying distances from the sun, while the earth and the planets move round the sun at distances which, though large in themselves, are excessively small compared with the distance of the stars from the sun, or from one another. Nevertheless, the eye cannot distinguish the fact that the planets in the sky are nearer than the stars; and for many purposes it is convenient to think of them all as placed on the inner surface of a very large sphere within which is the sphere of our earth.

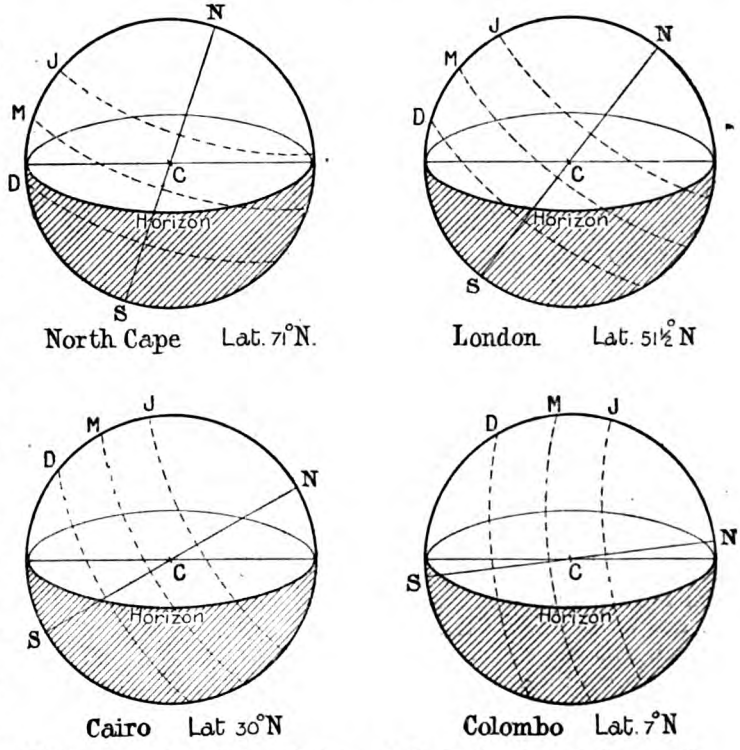


Diagram to show how variations of the inclination of the earth's axis affect the points of rising and setting of the sun.

Our earth turns upon its axis, which passes through the North and South Poles of the Earth. If this axis is produced ever so far both ways it will at last cut the celestial sphere in two points, which are the North and South Poles of the sky. Midway between the North and South Poles of the Earth lies the great circle of the Equator. If we imagine the plane of this circle extended ever so far all ways, it will cut the celestial sphere in the Equator of the sky; and, of course, if one draws a straight line from the centre

of the earth to the point where an observer is supposed to be standing and then produces it ever so far, it will cut the celestial sphere in the point which is vertically over the observer's head, his zenith.

We do not pretend that all this is exactly easy to imagine, and there is at first a particular difficulty in remembering that, whereas we are looking at the celestial sphere from the inside, we have to draw it as if we were looking at it from the outside. But with the help of a globe and a little thinking about it, the difficulty very soon disappears, and we may proceed with confidence.

Apparent Motion of the Sun

We speak of the motion of the sun among the stars, but always under the disadvantage that the sun makes the sky so bright that we cannot see the stars when the sun is above the horizon. There are people, in fact, who are surprised to learn that the stars are there at all, around and behind the sun, and that they can be seen with the telescope—at any rate, the brighter of them—if we know where to point the telescope. But the fact that the sun does move among the stars is evident immediately one remembers that the stars we see in summer are, to a large extent, different from the stars we see in winter. If the sun did not move among the stars they would naturally be the same.

The name of this path among the stars is the Ecliptic, and it corresponds in place on the celestial sphere to that mysterious circle which we find on the terrestrial globe. The path is inclined to the celestial Equator about $23\frac{1}{2}°$, cutting it at two opposite points, so that one half of the path lies to the north of the Equator and one half to the south. At the Spring Equinox, about March 21st, when, according to the calendar, Spring begins, the sun is at that crossing point moving from south to north. At midsummer he is farthest north. About September 24th, at the beginning of Autumn, he crosses again to the south of the Equator, and just before Christmas he reaches his farthest south.

And now we can see how these motions of the sun, north and south of the Equator, give us the variation in the length of day and night at different seasons of the year. If we turn to the diagram on p. 31 we find a point J which represents the position of the sun at midsummer in June. D is his position in December at midwinter and M half-way between the two at the Spring and Autumn equinoxes.

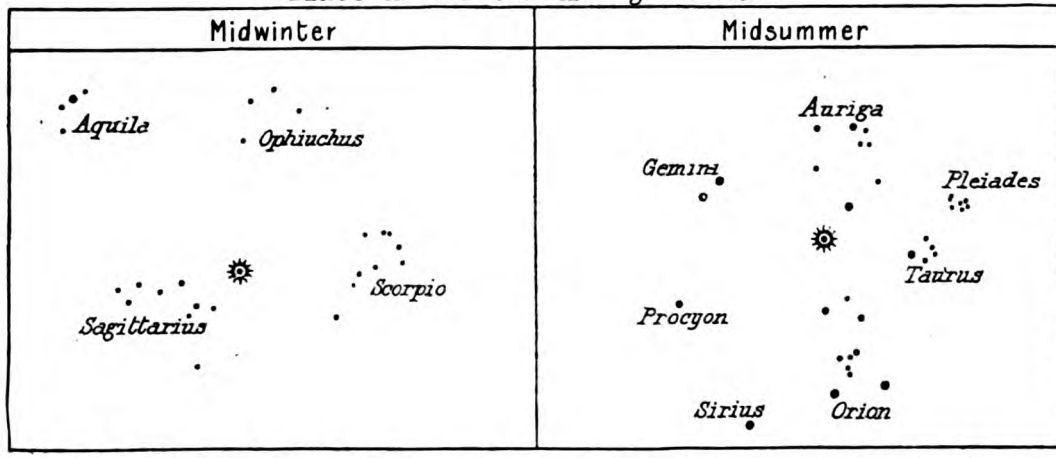
Real Motion of the Earth

Having imagined this, we have to take the further step of remembering that these apparent motions of the sun are really due to the motion of the earth. The earth both turns on its axis and moves in a path round the sun. To an observer upon the earth it seems that the earth is at rest, and that the motions are due to the sun and the stars.

It was Copernicus who established the doctrine that things are far from what they seem, and that in reality the sun may for these purposes be taken as fixed, while the earth and the planets move round him.

In the next "lesson" we will consider the proofs of this doctrine. A. R. H.

Place of the Sun among the Stars



The fact that the sun moves among the stars is evident immediately one remembers that the stars we see in summer are different from the stars we see in winter.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—I

Introduction.—There are several very cogent reasons why it is worth while to undertake the labour involved in acquiring a knowledge of Latin. First, it is the language of one of the three greatest literatures of the world, the other two being our own and that of ancient Greece. No one can attain more than a faint appreciation of Cicero's eloquence, the beauty of Virgil's poetry, the grandeur of Lucretius, or the pregnant force of Tacitus, without some knowledge of Latin. Some knowledge; not necessarily a thorough knowledge, though that may come in time when we have once experienced the spell of this most majestic and sonorous of human tongues.

Secondly, Latin, although dead, in that it has of course ceased to be a medium of conversation or correspondence, except in a few special cases, even among the learned, is still very much a living force, in that it is a part of the life-blood of the principal languages of modern Europe.

French, Spanish, Portuguese and Italian were evolved from Latin, which is in consequence the key to four modern languages. English also has been profoundly influenced by Latin; in truth, a knowledge of Latin is indispensable to a thorough understanding of our own language. We rarely open our lips without employing some Latin derivative; when we come to write, especially on learned subjects, our language is full of them.

Lastly, there are qualities in the language itself, apart from its literature and the heritage of verbal wealth it has bequeathed to our modern tongues, that make the study of Latin peculiarly valuable as a mental training. In structure it is the most logical of languages. In Latin one can see more clearly than in any other how sentences are put together, and what reasons underlie their construction. It might be described as a wonderful piece of mechanism or a perfect tool, working with the most admirable efficiency. For though its material was limited—the Latin vocabulary being a small one compared, for instance, with English, Greek, or Sanskrit—the logic of its structure enabled it to express the finest shades of meaning and the most recondite thought with triumphant force and accuracy.

Alphabet.—The Latin and the English alphabets are identical, except that the former had no W, and that in classical Latin, or that of the golden age of Latin literature (84 B.C. to A.D. 14), one letter, I, was used for the vowel I and the consonantal I (sometimes written J). One form, V, was employed also for both U and V, but for the sake of convenience this usage is now rarely adopted.

Pronunciation.—Two modes of pronouncing Latin are in vogue in England at the present day: one in which the vowels and consonants are given the same value as in English (final **e** being always sounded), the other approximating as far as we are able to that of the Romans themselves, although, it must be remembered, the precise sound, especially of their vowels, is to a great extent only a matter of conjecture.

For our purposes, it will be sufficient to set forth the differences of pronunciation according to this latter system, and leave it to the student to decide whether it is worth while to pronounce Latin as nearly as is now possible in the way it was pronounced by Cæsar, Livy, and Virgil, and their readers, or for the sake of certain conveniences whether one should be satisfied with the conventional method. In any case, it is imperatively necessary that the laws governing quantity should be gradually learned, since it is upon quantity, or the relative duration of each syllable, that the rhythm of Latin poetry depends.

A vowel is long or short in quantity according to the time taken in pronouncing it.

In the word *utilitarian*, for example, the **u** and the first **a** are long; the other vowels are short. A long vowel is marked thus, **ō**, a short vowel thus, **ŏ**. If the vowel may be either long or short this is indicated thus, **ŏ̄**.

The pronunciations of vowels and consonants are as follows, according to the more correct method :—

ā as in *ah* or *father;* never as in *fate.*
ă as in *fat.*
ē as *a* in *fate*, or French **ê** in *fête.*
ĕ as in *sped.*
ī as in *machine*, or as *ee* in *feet.*
ĭ as in *sit.*
ō as in *grow.*
ŏ as in *not.*
ū as in *brute*, or as *oo* in *shoot;* never as *u* in *acute.*
ŭ as in *full*, or as *oo* in *good.*
ae as *a* in *hate.*
au as in German *haus*, nearly as *ow* in *town.*
ei as in *feint.*
eu as in *feud.*
oe nearly as *oi* in *boil.*
ui as in *étui*, or as *we.*
c always hard like *k*, as in *can.*
g always hard as in *get.*
i consonant (j) as *y* in *year.*
n before *c* or *g* as *ng;* thus *incipit* is pronounced *ing'kipit.*
r is trilled or rolled, as in *terrier.*
s as in *hiss*, not as in *his.*
v as *w*, thus *vānus* is pronounced *wah'nus.*
x as *ks* in *wax;* never *gz* as in *exact.*
z as *dz* in *adze*, or *zz* in *intermezzo.*
bs as *ps;* thus *urbs*, city, is pronounced *oorps.*

ch, **ph**, **th**, as *k*, *p*, or *t*, followed by the aspirate, as in *sinkhole*, *loophole*, *rathole.*

gu, **qu**, **su**, before a vowel, as hard *g*, *k*, or *s*, followed by *w*, as in *guano*, *queer*, *persuade.*

Accentuation.—The accent in words of two syllables is on the first syllable; thus **nau'ta** and **ă'qua** are accentuated as the corresponding English words *saílor* and *wáter*, though the stress is not quite so pronounced. Words of more than one syllable are accented on the last syllable but one—the penultimate—if that syllable is long, thus **făcē'tē**, *merrily;* on the last syllable but two—the antepenultimate—if the penultimate is short, thus **fă'cĭlĕ**, *easily;* while if the penultimate may be either long or short the accent varies accordingly, thus **tĕnĕbrae**, *darkness*, may be either **tĕnē'brae** or **tĕn'ĕbrae.**

The Inflexion of Nouns.—English was once an inflected language, but most of its inflexions have long disappeared. We have relics in words like *brother*, plural *brethren*, possessive *brother's*, *brethren's;* in the modifications of verbs, *swim*, past *swam*, past participle *swum* and in the comparative *higher* and the superlative *highest* of the adjective *high.* Latin, like Greek, is a highly inflected language.

Inflexion is the alteration of the form of a word, especially in the termination, giving it a different meaning or a different function in the sentence. Thus we say in English: *the boy runs*, *the father beats the boy*, or *a book is given to the boy*, without altering the form of the word *boy* to indicate the change of case. In Latin the sentences would run: **puer currit, pater ferit puerum,** and **liber datus est puero**, where the word **puer**, *boy*, has one form for the nominative or subject of the sentence, another for the accusative or direct object, and a third for the dative or indirect object.

Of the case-inflexions which once existed in English the places have been taken for the most part by prepositions, though the possessive remains, as in *the boy's father*, *boy's* corresponding to the genitive **pueri** in **pater pueri.** The objective or accusative case also survives in some pronouns, as *him*, *them*—nominative *he*, *they.*

The cases in Latin are six, as follows :—

(1) The **nominative** denotes the subject of the sentence (and also the predicate after the verb *to be*); thus **puer currit**, *the boy runs*, and **puer dux erit**, *the boy will be a general* (compare English, *It is I*).

(2) The **vocative** is the case of the person addressed; thus **domine**, *O master!*

(3) The **accusative**, corresponding to our objective, is that of the direct object of a transitive verb; it also follows many prepositions; thus **pater ferit puerum**, *the father strikes the boy;* **pater ad puerum venit**, *the father comes to the boy.*

(4) The **genitive**, to which our possessive case roughly corresponds, expresses possession, origin, and other relations expressed by the preposition *of;* thus **horti patris**, *the father's gardens;* **templa deorum**, *the temples of the gods;* **montes auri**, *mountains of gold;* and **amor pudoris**, *love of modesty.*

(5) The **dative** is the case of the indirect object of a transitive or intransitive verb; thus **pater dedit librum puero,**

the father gives a book to the boy; **videtur mihi,** *it appears to me.*

(6) The **ablative** expresses relations of place or time, the agent by which something is done, or the source or place whence (in English its meaning is conveyed by prepositions, especially *in*, *by* or *with*, and *from*; in Latin it is used sometimes with and sometimes without a preposition); thus **natus obscuro loco**, *born in an obscure place;* **in tempore**, *in time;* **oppidum ab hoste munitur**, *the town is being fortified by the enemy;* **hostis oppidum aggere munit**, *the enemy is fortifying the town with a rampart;* **longe a portu**, *far from the harbour.*

A **locative** case occurs in the declension of some words, especially names of places; thus **Romae**, *at Rome;* **Carthagini**, *at Carthage;* **domi**, *at home.*

Gender and number are also marked by inflexions, Latin having two numbers—singular and plural—as English, the plural having also its case-endings. There are three genders in Latin—masculine, feminine, and neuter. Substantives denoting persons of the male sex are masculine, and those denoting persons of the female sex feminine, as in English; but many substantives denoting inanimate things are some masculine and some feminine. Neuter nouns are those to which no sex has been attributed.

Gender will be indicated in future pages by the abbreviations m., masculine, f., feminine, n., neuter, and c., common.

The methods of forming the case of substantives are called declensions, and are five in number. In words of the first declension the nominative singular ends in **a**; in fact **a** is its characteristic letter. The declension to which any word belongs may be discovered by noticing the vowel preceding the termination **-rum** or **-um** of the genitive plural, which in this case is always **a**. All nouns in this declension are feminine, except names of male persons or of rivers.

The following declension must be got by heart, careful note being taken that the base in the first word is **mens-** and in the second **naut-**. The base must always be recognized before a word can be declined correctly.

First Declension

Mensa (f.), *table*, base **mens-**.

	Sing.	*Plur.*
Nom.	**mensă**	**mensae**
Voc.	**mensă**	**mensae**
Acc.	**mensam**	**mensās**
Gen.	**mensae**	**mensārum**
Dat.	**mensae**	**mensīs**
Abl.	**mensā**	**mensīs**

Nauta (m.), *sailor*, base **naut-**.

Nom.	**naută**	**nautae**
Voc.	**naută**	**nautae**
Acc.	**nautam**	**nautās**
Gen.	**nautae**	**nautārum**
Dat.	**nautae**	**nautīs**
Abl.	**naută**	**nautīs**

E. A. B.

FRENCH.—I

Introduction.—It is unnecessary to insist on the advantages of a knowledge of French to the Englishman of the present day.

French has been, of course, the language of the legations for many years, and long used for drafting international treaties on account of its exquisite precision and unambiguity. For those taking up the profession of diplomacy, a knowledge of the language is a necessity, but it is hardly less indispensable to thousands engaged in very different occupations.

Our intercourse with our neighbours across the Channel grows more intimate year by year, and for those employed in business with France the ability to speak and write the language is obviously of supreme importance. From a commercial point of view, moreover, it will carry one much farther, as, in addition to the other countries, such as Belgium and Switzerland, where it is actually a mother tongue, experience will show that it may often be used for correspondence with Italy, Russia, Turkey, Spain, and South America, where it is generally adopted by business houses. It is, indeed, an international language.

The question of pronunciation is, of course, a difficulty. Accurate pronunciation can be gained only by mixing with French people; but careful attention to the directions given in the following lessons will certainly enable the student to pronounce most words quite passably. In any case, this course will enable him to read and write the language, and enjoy the gems of French literature.

Alphabet.—The French alphabet consists of twenty-six letters as the English:—

Character	*Name*	(pronounced)
A	**a**	a (*ah*)
B	**b**	bé (*bay*)
C	**c**	cé (*say*)
D	**d**	dé (*day*)

Character	*Name*	(pronounced)
E	**e**	é (*eh*)
F	**f**	effe (*eff*)
G	**g**	gé (*gay*)
H	**h**	ache (*ashe*)
I	**i**	i (*ee*)
J	**j**	ji (*zhee*)
K	**k**	ka (*kah*)
L	**l**	elle (*ell*)
M	**m**	emme (*em*)
N	**n**	enne (*en*)
O	**o**	o
P	**p**	pé (*pay*)
Q	**q**	ku (*koo*)
R	**r**	erre (*airr*)
S	**s**	esse (*es*)
T	**t**	té (*tay*)
U	**u**	u (*oo*)
V	**v**	vé (*vay*)
W	**w**	double vé (*doobl vay*)
X	**x**	ics (*ix*)
Y	**y**	igrec (*ee grek*)
Z	**z**	zède (*zade*)

Accents.—There are three signs, known as accents, placed over vowels, the acute (′), the grave (`), and the circumflex (^). These are used to modify the sound of the vowels, and must not be confused with the tonic accent (′) used in English and other languages to mark stress.

The acute accent (′) is placed over **e** when this has the close sound, as in **clarté,** *clearness*, the sound of *ay* in *ray* pronounced short.

The grave accent (`) over **e** indicates the open sound of *ay* in *ray* fully pronounced, as in **élève,** *pupil*, which is identical with the *ai* in **haine** or the *ei* in **peine.**

It does not affect the sound of **a** or **u,** but serves to distinguish words spelt alike but having different meanings, as **la,** *the*, **là,** *there*, **sur,** *on*, **sûr,** *sure*. Similarly, **des,** *some*, **dés,** *thimbles*, and **dès,** *as soon as*, are differentiated by the accents.

The circumflex accent (^) indicates that the vowel has the long sound, as in **âme,** *soul*, **bête,** *beast*, **gîte,** *lodging*, **rôle,** *part*, **mûr,** *ripe*. As a rule, the circumflex accent shows that some contraction has taken place, usually that an **s** has been dropped. Thus **tête,** *head*, was formerly spelt **teste, épître,** *letter*, **epistre.**

Note that names of months and days, and adjectives derived from proper nouns, do not begin with capital letters in French, thus **août,** *August*, **dimanche,** *Sunday*, **français,** *French*.

Vowels.—With the five simple vowels **a**, **e**, **i**, **o**, and **u**, must be grouped the vowel **y,** which in French is a vowel having the same sound as **i,** and rarely has the sound of the English consonantal **y.** There are also two compound vowels, **eu** and **ou,** which have approximately the sound of *er* in *her* and *oo* in *fool*, as in **heure,** *hour*, and **route,** *highway.*

These vowels may be long or short, as follows :

Long	**a,**	as in *father,*	ex.	**pâte,** *dough*
	e,	,, *fête*	,,	**bête,** *beast*
	i,	,, *machine*	,,	**île,** *island*
	o,	,, *bone*	,,	**rôle,** *part*
	u,	,, "*guid*"	,,	**août,** *August*
	eu,	,, *slur*	,,	**jeûne,** *fast*
	ou,	,, *fool*	,,	**croûte,** *crust*
Short	**a**	as in *cat,*	ex.	**patte,** *paw*
	e	,, *met*	,,	**jette,** *throws*
	i	,, *sin*	,,	**lisse,** *smooth*
	o	,, *pot*	,,	**dévote,** *devotee*
	u	,, *tun*	,,	**hutte,** *hut*
	eu	,, *her*	,,	**jeu,** *play*
	ou	,, *put*	,,	**mou,** *soft*

The combination **eu** or **œu** is almost equivalent to **er** with the English indeterminate **r.**

Diphthongs.—The combination of two simple vowels pronounced by one emission of the voice is called a diphthong. In French, diphthongs are formed by the combination of **i, o, u,** or **ou** with a following vowel, thus :—

i diphthongs—**ia,** as in **liane,** *liana ;* **ie,** as in **lierre,** *ivy ;* **io,** as in **pion,** *pawn.*

o diphthongs—**oa,** as in **moabite,** *Moabite;* **oe,** as in **moelle,** *marrow ;* **oi,** as in **foi,** *faith.*

u diphthongs—**ue,** as in **écuelle,** *bowl ;* **ui,** as in **ruine,** *ruin.*

ou diphthongs—**oua,** as in **louage,** *praise ;* **oue,** as in **rouet,** *wheel ;* **oui,** as in **jouir,** *enjoy.*

As already noted the combinations **ai** and **ei** (and of course **ay** and **ey**) have the sound of open **e.** When the vowel **y** follows another vowel, it combines with this, but retains its force in the following syllable ; thus **moyen,** *moa-yen*, **pays,** *pay-ee*. The combinations **au** and **eau** have the sound of **o,** as in **chevaux,** *horses*, **beauté,** *beauty.* **Oi** has a sound between *oah* and *wah*, as in **roi,** *king*, **foi,** *faith.*

When two consecutive vowels do not form a diphthong but are to be pronounced separately a diæresis is put over the second vowel as in **ciguë,** *hemlock*, **haïr,** *to hate.*

Consonants.—Many of the consonants are sounded differently in French from the English pronunciation.

Before **a, o, u, l,** and **r,** the letter **c** is usually pronounced as **k.** When it is to be pronounced soft (that is as **s**) before these letters, a sign (ˌ), called the cedilla, is placed underneath, as in **façade,** *fasahd.* Before **e, i,** and **y,** it is always pronounced like **s.**

Examples:—

canne,	*kan.*
cour,	*koor.*
cité,	*seetay.*

Except before **e, i,** and **y, g** is always pronounced soft, like **zh.**

Examples:—

gâteau,	*gah'to.*
gigot,	*zheego.*
geai,	*zhay.*

h is hardly ever sounded in French. In **l'homme** elision takes place, i.e. the final vowel of **le** is dropped before **h** mute, as it would be before a vowel, thus **l'état** (*letah*) *the state.* **h** aspirate is rarely sounded, but elision does not take place before it, thus **le héros,** *the hero,* **la haine,** *hatred.*

j is pronounced like **zh,** as in **jadis** (*zhadee*), *formerly,* **jaloux** (*zhaloo*), *jealous.*

k and **q** have the same sound as in English, **q** being always followed by **u** and the two sounded as **k**; thus **qui** is pronounced *kee.*

ch is pronounced as **sh,** thus **chaud,** pronounced *sho,* except in words derived from Greek, as **archétype,** pronounced *arketeep.*

r is heard more in French than in English. It is slightly trilled. If the word *barrel* be spoken, both **r's** being sounded distinctly, it will be understood what is meant by the word "trilled."

s is hard except when it occurs between vowels, when it has the soft **z** sound.

Examples:—

seau,	*so.*
rasoir,	*rah-zoarr.*

t has the sound of **s** when it comes before **ia, ien, ion,** in the middle of a word.

Examples:—

martial,	*mar-see-al.*
portion,	*por-see-on.*
patience,	*pah-see-anss.*

x is really a double consonant, pronounced as in English, **ks** or **gz,** except at the beginning of a word, when it has the sound of **z.**

Examples:—

taxe,	*taks.*
exemplaire,	*egzamplairr.*
xyste,	*zeest.*

w, usually pronounced as **v,** is not properly French, and occurs only in foreign words and their derivatives, e.g. **wagon** (*vah-gon*), **warrant, whisky,** and **whist** are pronounced much as in English.

Remember that **y** is a vowel corresponding to **i.**

l or **ll** following **i** is called *l mouillé,* and is practically equivalent to **y.** Thus **fille,** approximately *fi-ye*; **travailler,** *trava-ye.*

n following **g** is called *n mouillé,* and is equivalent to **ny,** as in **montagne, Boulogne, Cogne.**

The two consonants **m** and **n** in combination with certain vowels give a nasal sound that may be classified as follows:—

(1) **am, an, em, en,** as in **ambre,** *amber,* **ange,** *angel,* **bien,** *well,* **embarras,** *embarrass,* **vent,** *wind,* **puissance,** *power.*

(2) **im, in, ym, yn, aim, ain, ein,** as in **centaine,** *hundred,* **essaim,** *swarm,* **fin,** *end,* **industrie,** *industry.*

(3) **om, on, eom,** as in **leçon,** *lesson,* **sommeil,** *sleep,* **pont,** *bridge.*

(4) **um, un, eun,** as in **aucun,** *any,* **(à) jeun,** *hungry.*

These sounds are often described as the nasal vowels, the first being called nasal **a,** the second nasal **e,** the third nasal **o,** and the last nasal **eu.** The sound of these vowels is combined with nasal **n** (i.e. the **n** in *anger* or *conquer,* without the **g** or **k** sound), care being taken not to exaggerate the nasal character of the sound—a common fault.

Note that **m** or **n** followed by a vowel is not nasalized, thus **anormal,** *a-nor-mal*; also that when the **m** or **n** is doubled the nasal sound is lost, as in **inné,** *in-nay.*

Final consonants (especially **d, t, r, s, x,** and **z**) are often mute, as in **chaud** (*sho*), *warm,* **jaloux** (*zhaloo*), *jealous,* **jadis** (*zhadee*), *formerly,* **gigot** (*zheego*), *leg of mutton.* When a word beginning with a vowel follows, however, the consonant is sounded, as in **sous-officier,** *non-commissioned officer,* **avait-il,** *had he?*

When a verb ending with a vowel and a pronoun beginning with one appear in the interrogative form, a **t** (called the euphonic **t**) is inserted between them, as in **ne donne-t-il pas,** *does he not give?* **aura-t-il,** *will he have?*

In the next lesson we shall study the words of the French language.

E. A. B.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

INTRODUCTION

THE progress which has been made in Geography in this country during the last thirty-five years is noteworthy. Its status as a field of investigation and study, especially in its bearing on human interests, has been raised to a much higher platform than it ever occupied before, while its value in education on these reformed lines has been widely recognised in universities and in schools of all grades.

The importance of Geography was recognised long before its recent development in England. In fact, Geography may be regarded as the mother of all the sciences; and although her children have set up for themselves, Geography has still close relations with many of them.

The Ultimate Problem

In England, the Royal Geographical Society, founded in 1830, has been one of the most active of the societies; it has not only added vastly to our knowledge of the Earth's surface, but, as an examination of its records will show, has ever kept in view the function of Geography as a department of scientific research, for the promotion of which, according to its rules, it was founded. But, in the main, up to about 1885 geographers and geographical societies in England were concerned with the acquisition and publication of information concerning the surface of the earth, with which it is the function of the subject to deal. Accurate and detailed information concerning the geosphere, hydrosphere and atmosphere—the land, the ocean and the air—is indispensable to an investigation of distributions, relations and influences, and most important of all is the interaction between man and his geographical environment, which is the ultimate problem of Geography in its latest developments in England.

The additions to our knowledge of the lands and seas of the globe during the last sixty years have probably been greater than during any previous period of equal length, not excepting that which followed 1492, when Columbus stumbled upon a New World. The two Poles have been reached, and large additions made to our knowledge of the Polar Regions. The unknown two-thirds, at least, of the Dark Continent, have been more or less provisionally mapped, and all but an insignificant fraction partitioned among the Powers of Europe. Great areas of North America have been surveyed and occupied, while much has been done for the exploration of Central and South America. The map of Asia has to a large extent been reconstructed, whilst the vast unknown interior of Australia has been traversed in all directions. Even much of Europe has been resurveyed. A new department of science, Oceanography, has been created, as the result of the *Challenger* and other oceanic surveys. The time, therefore, seems ripe for an arrangement and co-ordination of all this knowledge with special relation to the life and activities of humanity.

Geography as a Science

The educational and practical value of Geography was early in its career recognised by the Royal Geographical Society, which sixty years ago endeavoured to foster it in our public schools by presenting medals for examinations. In the seventies its Council sought to get the subject introduced into the universities. But it is no wonder that the universities turned a deaf ear to the appeal when we examine the textbooks and other geographical literature as well as the maps of the period. This led to an investigation by the Geographical Society of the position of the subject on the Continent, and the result of this inquiry led to the ample recognition of Geography in Oxford and Cambridge and other universities in the Kingdom, and to radical reforms in the programmes of schools of all grades.

It is sometimes asserted that Geography cannot be a science as it is purely descriptive. Why may not a description be on scientific lines? And we have already got far beyond the descriptive stage, though, in this country, we are comparatively new to the work, only feeling our way, as it were, only trying to find out exactly what are the conditions under which our line of research will produce the best results, what are the limits within which we must work. Ellsworth Huntington, one of the most active and most original of our younger geographers, has the fullest belief in the influence of geographical conditions on history and other human activities; but he maintains that the claims made in this respect are often too vague to convince the sceptical historian. What we want, he says, is a more precise statement as to the nature and amount, the quantity and quality, in each case of this environmental influence compared with various other elements. Probably we can never reach mathematical precision in this respect, as we might do in other departments of our subject; but it would be a splendid exercise in geographical research and in mental training for the qualified student of the subject to tackle the problem in certain specific instances.

Man and his Environment

It is obvious on the face of it that the many features which are distributed over the surface of the earth must have a marked influence on certain of the activities of man who lives and moves and has his being among them. Mountains and plateaux and plains in all their varieties; the distribution of water in its various forms of rivers, lakes, oceans; the climatic conditions—rainfall, temperature, prevailing winds—acting on these features and being reacted upon by them—these are some of the great factors with which the geographer has to deal in working out his final problem of the action and reaction between man and his geographical environment.

The direction and altitude and configuration of mountain ranges may have a marked influence on human movements and human settlements and also on the climate of the regions dominated by them. The geological structure of the mountains, the surface characteristics of plains and plateaux, the distribution of water in the shape of rainfall, rivers and lakes will seriously affect human movements and the economic and hygienic conditions which largely determine the character and extent of human settlements. Were the Sahara as well watered as the Congo basin it could maintain millions of a population. In primitive conditions mountains, deserts, oceans, and even rivers may act as great barriers against communications; but as man evolves, mountains may be tunnelled, deserts crossed by railways, and rivers and oceans become great highways for traffic.

The factors referred to have, of course, a potent influence on the distribution of plants and animals, which again forms a ruling factor in determining the migrations and settlements of man; while another factor—at least in later stages of human evolution—has been the distribution of minerals.

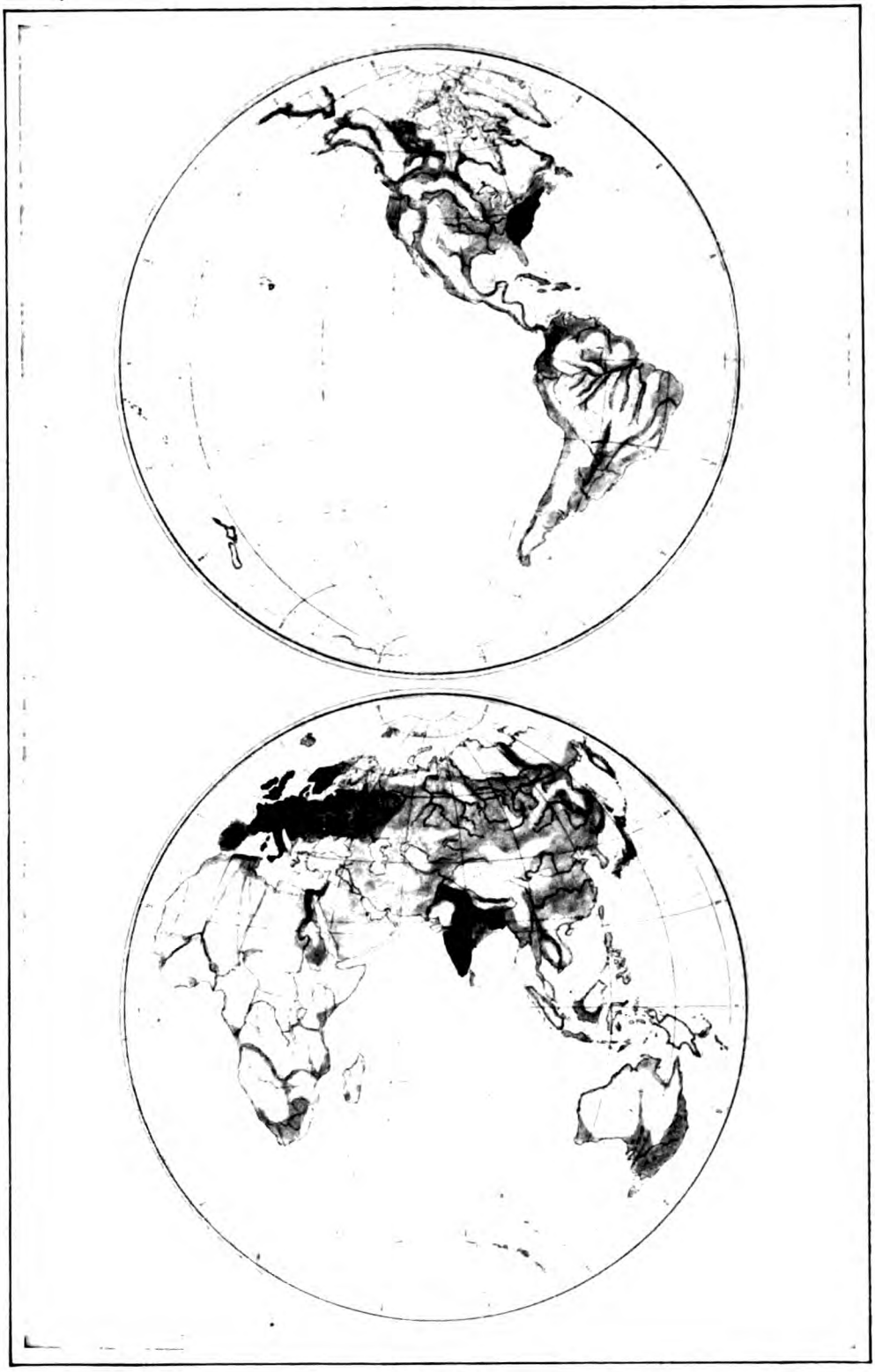
Explorers' Achievements

These are only a few of the data with which the geographer has to deal in working out the problem of the inter-relations between environment and man. I have dealt with them in a general and broad fashion, and have not attempted to appraise the precise part played by each factor in the evolution of the race. The time is hardly ripe yet for dealing adequately with the problem. The geologist, the meteorologist, the astronomer, the botanist, zoologist, and even the sociologist, physiologist, and psychologist must have his say as to the part played by the various forces that have been at work to mould man since he began his career on the earth and enabled him to reach the stage which in his various types he has attained at the present day. And yet, when one attempts to analyse the various influences which have been at work, it will be evident that geographical conditions in their broadest sense are an element in all of them.

How far have geographical conditions influenced race?

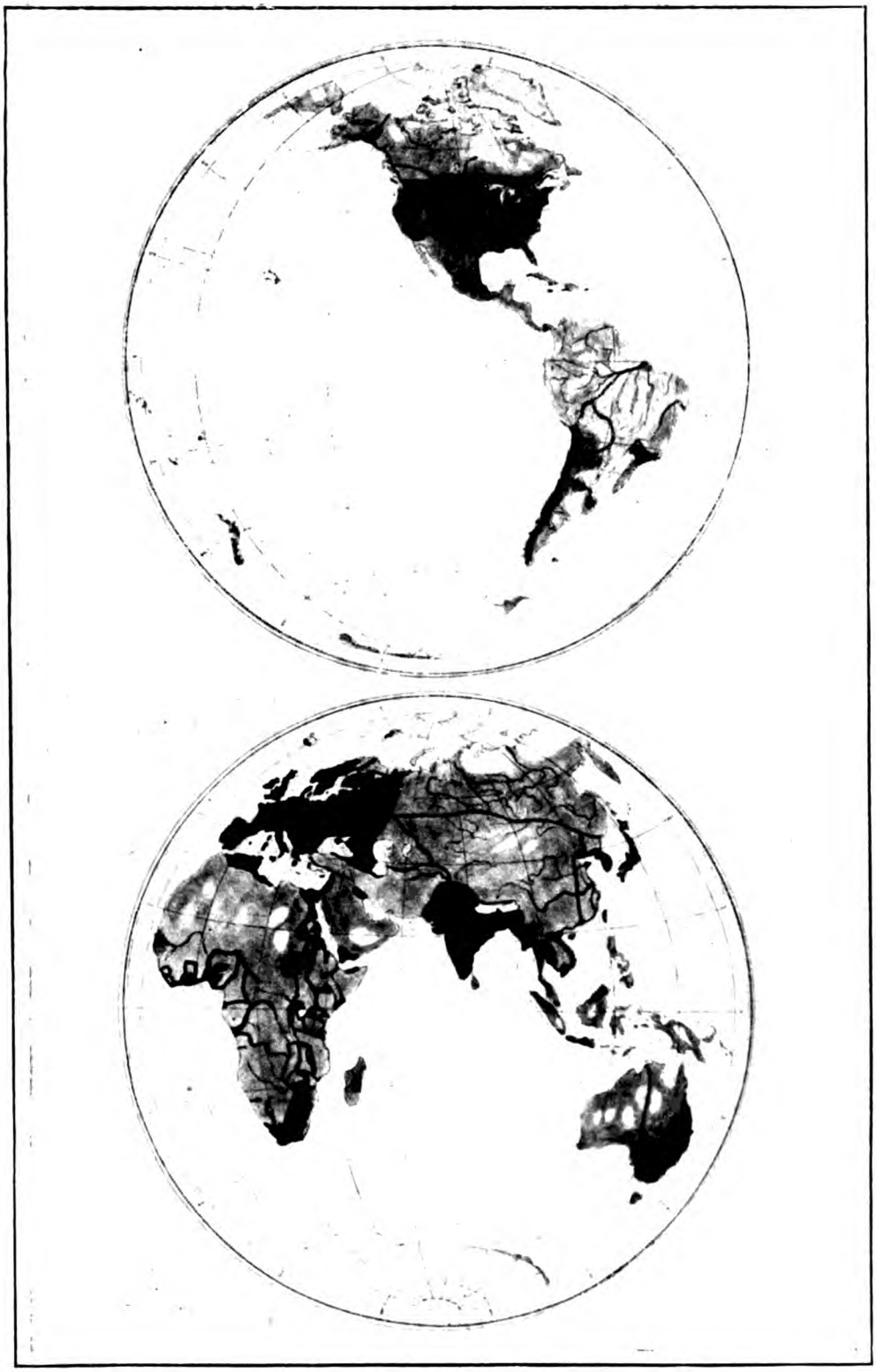
Supposing man originated in a single strain, and not at various centres, how are the varieties in physique, in features, in colour, in character, in social conditions, in intellectual and material progress, due to geographical influences as distinct from others that may be regarded as non-geographical? Are what are regarded as racial characteristics unalterable? May they not be radically modified by transference to a totally new environment?

That is a problem of the greatest complication, and we are still far from possessing all the data that are necessary for its solution. But that a large proportion of these data must be distinctly geographical there can be no doubt.



IN 1860.

1. Mapped from Accurate Topographical Surveys
2. Mapped from less reliable Surveys (chiefly non-topographical)
3. Mapped from Route Traverses and Sketches
4. Entirely unmapped

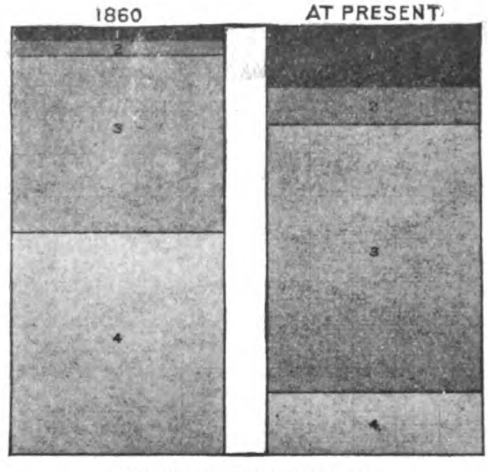


AT PRESENT.

1. Mapped from Accurate Topographical Surveys
2. Mapped from less reliable Surveys (chiefly non-topographical)
3. Mapped from Route Traverses and Sketches
4. Entirely unmapped

I have dealt at some length on the anthropogeographical aspect of the subject with a view of indicating the advanced stage which it has reached in the last half-century. Geography is no longer a catalogue of unrelated facts concerning the various features of the earth's surface; an accurate and full knowledge of them is no doubt indispensable, but mainly as the data with which to work out the great problems that I have indicated.

Reference has already been made to the unprecedented amount of exploration that has been accomplished during the last half-century, resulting in enormous additions to a more or less accurate knowledge of those features of the earth's surface with which it is the function of Geography to deal. Of a certain proportion of the surface we have an accurate knowledge of details recorded on maps of scales large enough to enable the geographer to realise their significance; for good maps form the basis of all geographical work. Besides these topographical maps, there are for many regions special maps recording distributions of various kinds, geological, botanical, zoological, human, showing how these are related to the distribution of the various physical features.



MAPPING THE EARTH.

Proportion of Earth's surface mapped. 1, from topographical surveys; 2, from non-topographical surveys; 3, from sketches, etc.; 4, unmapped.

Apart from the regions thus specially mapped, we have acquired during the half-century a fair general knowledge of the surface configuration of the earth as a whole. Of certain areas such a general knowledge might suffice so far as human interests are concerned, but the more thorough is our knowledge of all parts of the earth's surface the better able are we to judge to what extent its characteristics may be made to subserve human interests.

Notwithstanding all that has been accomplished during the half-century, there is ample room for scientific exploration and accurate mapping for generations to come. The great blanks that disfigured the map of Africa fifty years ago have no doubt been filled up, but it is doubtful if more than one-tenth of its surface has been mapped with anything like accuracy. Of Australia vast areas have only been provisionally mapped, and the same may be said of Asia. Even in the case of Canada and the United States, much remains to be accomplished before these countries are as thoroughly mapped as the United Kingdom, India, and even Japan. Of South America only fragments have been fairly mapped, and probably a million square miles are entirely unexplored.

The maps and diagram (supplied by Mr. E. A. Reeves, Map Curator and Instructor in Surveying to the Royal Geographical Society) which illustrate this article will show what has been done and what remains to be done ere the earth is adequately known. First, there are two maps of the Eastern and Western Hemispheres, one pair showing the state of our knowledge in 1860 and another pair showing our knowledge at the present day. The darkest tint shows the areas that have been mapped from accurate topographical surveys or rigorous traverses. The next darkest tint shows areas mapped from less accurate surveys, chiefly non-topographical. The lightest tint indicates land mapped only from route traverses and sketches; the uncoloured areas are those entirely unmapped and to a large extent unexplored. The contrast between 1860 and now is most marked.

The square diagram will make the position still more intelligible. While the entirely unmapped, it will be seen, has enormously decreased, the imperfectly mapped still covers considerably more than half the globe. A vast amount remains to be done.

But the lands of the earth are being steadily colonised or brought under the control of those races which have hitherto been most energetic in developing the resources of our globe; while the population of the earth as a whole is rapidly increasing. It will, therefore, become more and more necessary that man should have an adequate knowledge of the salient features and resources of his home, and the basis of such a knowledge is accurate survey and mapping.

J. S. K.

ART AND MUSIC:

***Contributors*:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).**

THE STUDY OF NATURE

THE student who goes to a school of art is apt to imagine that it is his teacher's business to make an artist of him. No doubt the teacher will do his best, but he is certain to fail unless the student supplements his instruction by becoming to a great extent his own teacher.

Education is a matter of co-operation between the master and the pupil; and the most valuable part is that brought by the pupil. He teaches himself more than anybody else can ever teach him; and whether his studies lead to success or failure depends largely upon the attitude that he takes up with regard to them.

The last thing the art student should try to do is to produce art—that is to come later. Nor should he strive to manifest his temperament; nor to interpret nature in the terms of his own individuality. In short, he should not do any of the curious things in which artists seem to delight. His business is to learn his trade, thus giving himself the power to use his talents and his knowledge to the best advantage.

Post-Impressionist and Cubist

The instruction which most benefits the student is that which enables him to reproduce nature with the greatest accuracy. When he can truthfully depict anything which he sees, then, and not till then, has he learnt the grammar of his craft and is ready to become an artist.

Having acquired this power (and it is very difficult) he can apply it how he likes; he can then begin to select and modify and recompose according to his fancy. But it is obviously essential to good art that he should modify nature because he wishes to do so, not because he cannot do anything else.

Every artist (except perhaps the most advanced) will occasionally see some aspect of nature upon which he feels that he cannot improve. If he is quite unable to reproduce this aspect faithfully, how hampered and how limited must be his art! Even if he wishes to become a cubist (I hope he will not) he must surely feel that it is better not to have taken to these weird forms merely because he is totally incapable of following the true curves of nature. Or if he wishes to become a post-impressionist (and again I hope not), it must be less humiliating to know that he depicts those ugly and degraded creatures which in this interesting art take the place of men and women, from choice, however mistaken, rather than from sheer inability to draw a wholesome human figure.

Training the Eye

So this is my advice to the art student: aim at acquiring the power of representing truthfully anything you have before you. Only in this way can you hope to become properly equipped for the difficult craft of the artist.

If you pursue this aim in a whole-hearted manner, you will make rapid progress.

One advantage of this pursuit is that it is very definite, and so much in art is deplorably vague. If a study direct from nature is placed side by side with the object it purports to represent, it is possible for anyone with normal eyesight to say if the two are really like one another.

We will suppose that our study is of some arrangement of still-life which remains for some time unaltered, and that it is seen in the quiet grey light of a studio. Then, if the study is placed in the same light as the object, and at such a distance that it looks of the same size, there is no reason why the two should not send practically identical messages to the retina. They are to the eye just patches of light and shade and colour. These patches have definite shapes which can be the same in both, the tints and values can be the same.

If they are not the same there is no valid excuse ; it is simply incompetence on the part of the student—an incompetence which it is his business to overcome. The discrepancies between the two, the object and the study, when pointed out by the teacher, can be seen by any student with normal eyesight, and consequently corrected until his eye becomes as trained as that of the teacher.

So stated, the problem seems a very simple one ; and, indeed, it is simple, but this training of the eye is strangely difficult.

Accidental Peculiarities

The difficulty is almost entirely mental. We all have to look at the world for practical purposes in an entirely different manner from that in which an artist should look at it. The constant training of our life from infancy upwards is to be able to recognise objects, to know that they are the same, in spite of their continually varying appearance. For instance, take the face of anyone who is well known to us.

As a pattern on the retina this face is continually varying in a most perplexing manner. The profile is quite different from the full-face ; the three-quarter-face is different from either ; sometimes the face is lit up from the right side, sometimes from the left, sometimes from above, occasionally from below. Sometimes there are deep shadows, sometimes there are none at all. In fact, as a pattern it is infinitely varied, and yet we recognise it at once in all its different manifestations. Indeed, it would be highly inconvenient if we did not.

We can only achieve this recognition by not paying attention to the variations. We must think of the head as a solid object, and be as little influenced as possible by what may be called its pictorial aspect at the moment—and yet this momentary aspect is the one the artist must seize. As a man, he cares nothing for the particular light and shade, or the particular foreshortening that the face assumes, but as an artist these accidental peculiarities are of the utmost importance.

Man v. Artist

In order to see things as they really look, the artist must forget the whole training of his lifetime ; without which training he would be unfit to live in the world. He must learn with the utmost difficulty to see his surroundings as a new-born baby sees them—just a flat pattern of light and shade and colour.

The man in him is continually fighting with the artist. All his natural instincts revolt against this monstrous endeavour to unlearn the laborious training which has fitted him to take his place in the world. After a while he establishes a sort of dualism ; he can switch on at will his artistic vision, having blinded the normal eyesight which concerns itself with the requirements of everyday life. But at the best it is a difficult process, and the fight is always going on.

It is this which constitutes the main crux of artistic training. Were it not for this mental struggle, the adequate representation of natural objects would be comparatively easy.

Of course, there are many fleeting aspects of nature which present difficulties of their own. They will not wait to be studied in the way that one can study an arrangement of still-life in a studio. To grapple with them the artistic memory must be trained.

This introduces a puzzling question. How far should the student rely on his memory ?

Many teachers advocate a regular course of memory training, and there is no doubt that it has certain advantages. To be able to impress upon one's mind some passing effect which cannot possibly be directly portrayed, so that it can afterwards be reproduced at leisure, is a most valuable accomplishment, and yet for the student it has its dangers.

Memory Sketches

A memory sketch can never be nearly as accurate as a direct study from nature. It is certain to have many faults of drawing and of colour, and yet the author of these faults will regard them with great complacency. He does not recognise them as faults or he would not put them into the picture. Of course, there is always this tendency to like one's own faults, but in direct studies there is nature to refer to—and an honest man will recognise his faults.

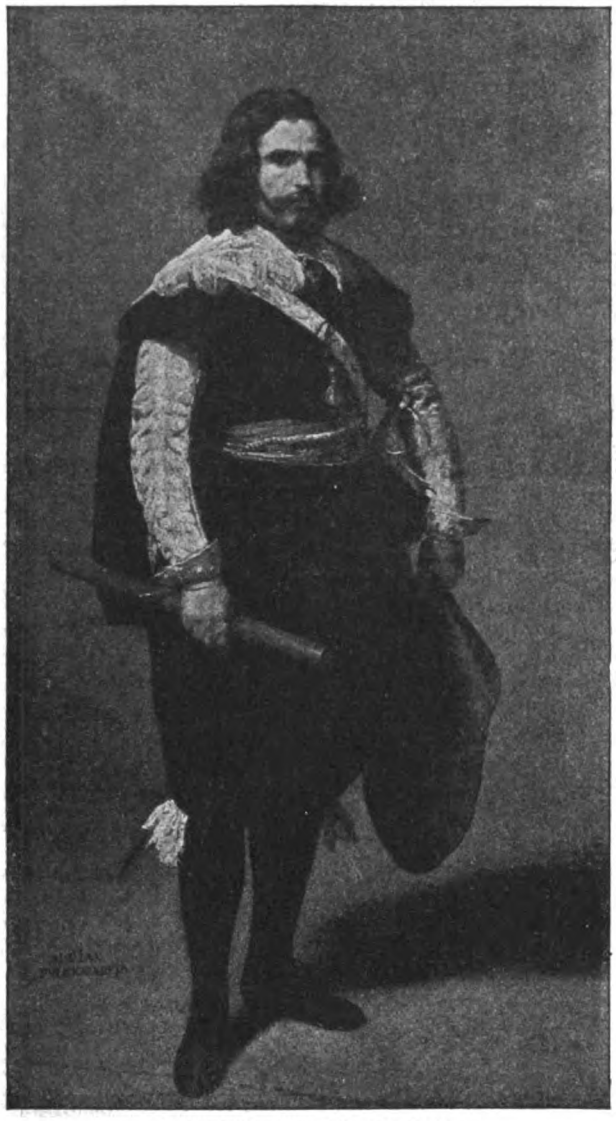
The danger of memory training is that it may destroy that high standard of accuracy which we are endeavouring so elaborately to build up. Therefore, I should not recommend it in the early stages of tuition, but it may be very valuable later.

I have so far left out any reference to the training of the decorative sense. This is a difficult question. The decorative sense can undoubtedly be improved by cultivation, but, unlike the representation of nature, there is nothing definite about it. A study either is or is not like the object it depicts, and there is not much room for difference of opinion as to its success in this respect—at least with normal-sighted people ; but there can be, and mostly is, a great deal of difference of opinion as to what is beautiful and what is

A GREAT LADY

Reproduced from the picture by the Hon. John Collier, who, in the article which begins on page 43, endeavours to guide the student to a proper appreciation of Art.

not. In spite of its difficulty, I cannot put this question aside, as I am one of those who hold that beauty is a very important element in art. I have already said that the student should not try to produce art, but it would be rather hard to debar him from cultivating his sense of beauty at the same time that he is acquiring the invaluable power to copy accurately anything that he has before him.



ADMIRAL PULIDA PAREJA.

From the portrait by Velasquez, from whose work the author draws lessons of much importance to students.

I will not attempt any definition of beauty; many people have essayed this task, but I do not think that any have succeeded. All one can say is that there is, on the whole, amongst civilised people a consensus of opinion as to what is beautiful.

As to human beings we are mostly agreed in admiring fine, healthy, well-grown specimens of men, women and children. The sort of beauty that is best found in a Greek statue is very fortunately taken as the ideal for the human race. It is a sound and healthy ideal.

Some people profess to find beauty in disease and degradation. There are many aspects of modern art which would seem to imply that the only people who are hopelessly unpictorial are the healthy and well grown. This is a fatal tendency both to art and to civilisation.

Yet there is a certain plausibility in the plea that the artist with his keener sympathy can discern beauty where the philistine can only see ugliness and squalor. Nature is seldom absolutely ugly. Rembrandt could show that there was beauty of colour in the carcass of an ox, and, what is much more remarkable, Velasquez could so paint the dwarfs and idiots who amused the decadent Court of Spain as to endow with a sort of charm even these step-children of nature.

Yet he would have done better not to have painted them. For lesser painters than Velasquez such a choice of subject would be intolerable.

If the sense of beauty in human beings is somewhat indefinite, it is much more so in everything else. There is very little agreement even as to landscapes.

How far do these questions concern the art student? I think he can well be improving his taste at the same time that he is learning his craft. For this the study of the great artists is of the utmost importance. The Greeks are still our masters with regard to human beings; their ideal has never been surpassed. After them come the artists of the Italian Renaissance.

With regard to the world at large there are the great landscape painters to teach our dull eyes how varying and how interesting are the aspects of nature. This study of the great masters supplemented by a constant observation of the world around us ought so to train the taste of the student that he can apply technique to good advantage. J. C.

MUSIC.—I

THOUGH musical, in that it is undoubtedly appreciative of music, the British race is strangely unmusical, in that—generally speaking—it is almost deliberately ignorant of the art or science of music.

Listening to music is a pastime in which everyone seems to find pleasure. But the study of music as a science is not one to which the average person has given much attention. He is frightened at the outset by dry rules which he lumps together under the head of "Theory." Theory, he considers, is only for those who propose following music as a profession, and can very well be dispensed with by those who have only time to take it up as a hobby.

If we think for a moment we shall see the fallacy of this line of argument. The average educated person has no more time to devote to literature or science than he has to music. But the average educated person has a good "working knowledge" of both.

In these days of cheap editions the poorest man can browse amongst the greatest authors from Plato and Pindar down to Masefield and Maeterlinck.

From the painting by [*F. P. Paulus*

"THE MOONLIGHT SONATA."

Beethoven (1770-1827) composing. Beethoven by means of his Sonatas did more probably than any other musician to popularise the piano.

It is regrettable that this is not the case with music. Cheap editions of music—for performance by voices or instruments—exist in plenty. But cheap books on music for popular use, of the same standard of excellence and the same standard of comprehensiveness as those on science, are conspicuously lacking.

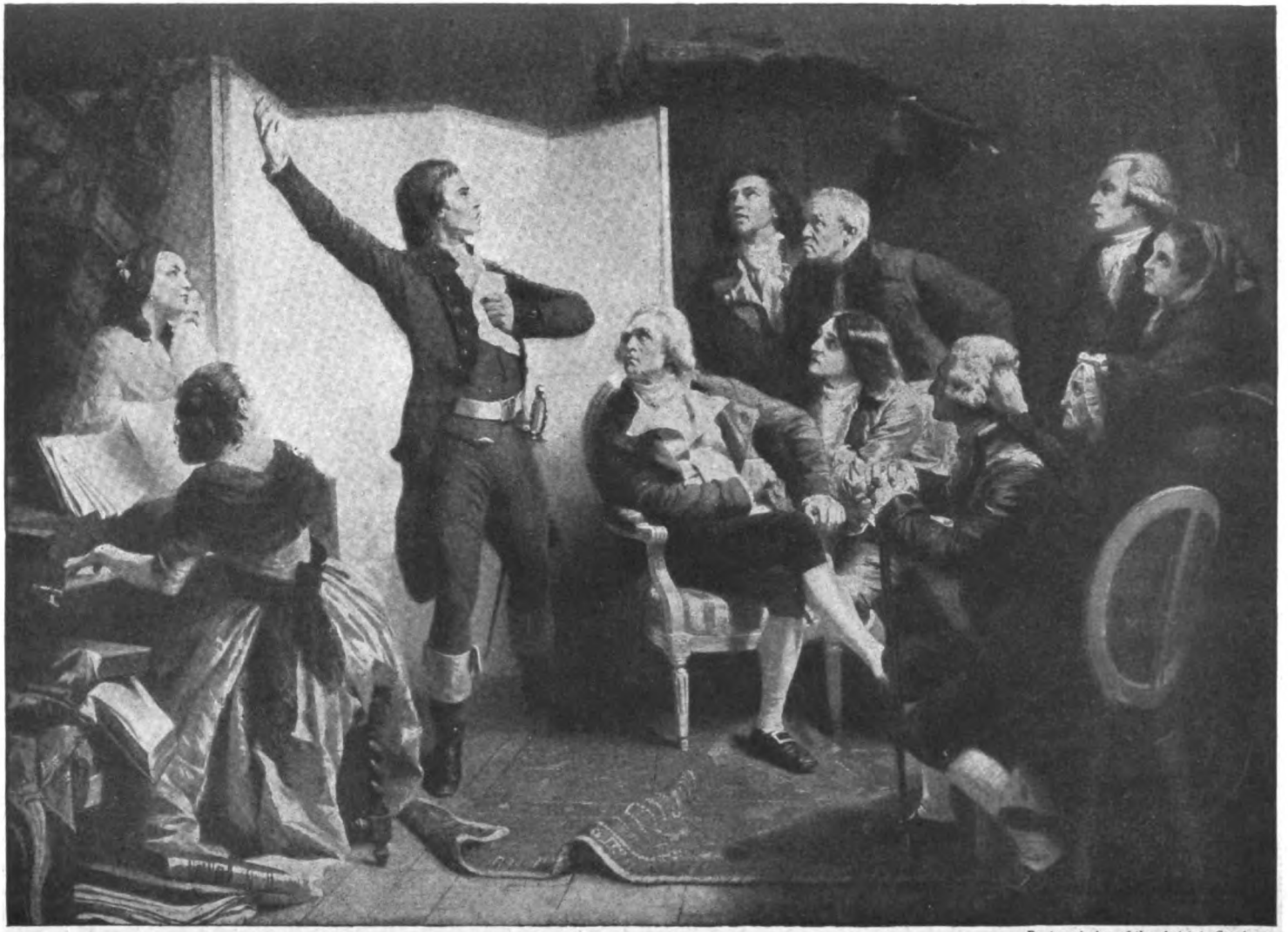
"Learned" books on musical subjects are as plentiful as could be wished, but the results of this musical research have not yet reached the multitude—to any appreciable extent—in popular form.

Under these circumstances the average person has been unable to acquire, in music, the same broad and comprehensive knowledge that is open to him in literature or science. He is thus shut out from one of the most fascinating of studies. The history of European music—which would read like a romance—is a sealed book to him, and we cannot wonder if he comes to regard the whole subject as one of mere amusement and recreation for the ordinary person, and of dull grinding at rules and exercises as far as the professional one is concerned.

The writer has often been astonished at the widespread idea—amongst people who were otherwise very well informed—that a composer of music "makes it up" out of his own head after laboriously learning a lot of rules that tell him how the trick is done. Let us start from a different standpoint; and before we begin the practical side of our subject let us go briefly over sufficient historical ground to make the position clear.

We must first remember that music is not only a science but an art as well, and if we are to grasp all that it means, we must look at it from both points of view. That will help us to understand much that is obscure in the music of the past; it will also throw much new light on the music of the present; and lastly it will help us to understand intelligently the latest types of music now being written by composers whom we might otherwise think were going off the track altogether.

We often hear unthinking people speaking of our present age—the age of the telephone,



By permission of the Autotype Company.

THE *MARSEILLAISE* SUNG FOR THE FIRST TIME.

On April 24th, 1793, during the excitement occasioned by the declaration of war on France by Bohemia and Hungary, Rouget de Lisle, a young officer in the French Revolutionary Army, wrote and set to music the hymn or song that was soon to become the national anthem of the French, and to be used as the song of liberty by every other nation.

the motor-car, the aeroplane, the submarine —as though we were superior to our forefathers of, say, Queen Elizabeth's time, to whom all these wonders were unknown. But we know that this is not so. Our forefathers had just as good brains as we have.

Shakespeare lived in Elizabeth's time, and was just as completely understood then as now—perhaps more so. All that has happened is that the sum total of our knowledge is greater than that of our sixteenth-century forefathers. Ever since the world began men have been first thinking their own thoughts and then communicating them to their fellows. It is in the nature of human beings to *express* their thoughts. The commonplace person expresses his, and just because they are commonplace they add nothing to the world's store of knowledge.

But it is different with the great men. They think greater things than their fellows; they give expression to their great and new thoughts, and the world's store of knowledge is the richer for them. They each express themselves in the language in which they think most deeply. The artist expresses himself in the language of painting; the architect in the language of stones; the poet in the language of verse; the composer in the language of music, and so on. But in every case it is that of a man *expressing himself* and what he feels, in those different languages. That is what Art and Literature are, viz. *self expression.*

Music as an Art

You may wonder why this point is insisted on at such length, when every educated person is ready to grant it without discussion in the case of, say, painting or poetry. The writer's reason is just this—the general ignorance of the "Art" of *music* is so great, that while most people are willing to regard it as an "Art," they labour under the impression that the notes, scales and chords on which it is constructed are a fixed quantity—something that has always existed —and that the composer's genius is only shown by the skill with which he can manipulate these notes, scales and chords.

Even so distinguished a person as Ruskin thought so, and in his *Seven Lamps of Architecture* wrote: "The chords of music .... have been determined long ago, and in all probability cannot be added to any more than they can be altered."

Now this is simply not true. The chords of music have never been fixed: they have constantly been added to; they are constantly being altered. The language of music follows the same laws as the language of ordinary speech. So long as it is *alive* its forms and modes of expression are constantly changing. The classical Greek and Latin languages do not alter, because the peoples who once spoke them have died out, and further development of their languages died with them. Hence we call them "dead languages." But take the language of any living nation—our own, for instance—it is always changing.

If you were to take up one of the many reprints of our English authors of medieval times you would be unable to read it without help. Even our great poet Chaucer uses hundreds of words of which you would be unable to tell the meaning. And later you will find Shakespeare using words and expressions now obsolete.

—as a Science

The same thing has always been happening with music, just because it is alive and in constant use. You could no more understand a piece of music of Chaucer's time than you could understand a poem of his without help. But once you could get the clue to their language (in other words, to the *idiom* in which they were written) you would be in a position to appreciate both.

You would never find anyone so foolish as to say that because Chaucer's English looks unintelligible to modern eyes, that Chaucer was not a poet, or that his was not one of the greatest minds of his time. But you do invariably find the writers of musical text-books talking in this disparaging way of the great musicians of the past, because their music is puzzling both to the eyes and the ears of people to-day.

If we do not understand Chaucer's "idiom" and we want to understand his poetry, we make an attempt to master his idiom. And so we ought to do with the ancient musical composers. But the writers of musical text-books (just because they do not understand the musical idiom of those remote times) dismiss the work of composers—as great in music as Chaucer was in poetry—as crude, imperfect, and even barbarous.

The absurdity of such an attitude must now be apparent to you. You, at least, will remember that, however unintelligible the works of the ancient composers may appear to us to-day, they were the great thoughts of great men, expressed in the idiom of their own day, and on that account entitled to our respect, even if we have not the leisure to master that idiom.

So much for music as an art. We have

also said that it is a science. Now the difference between an art and a science is roughly this—an art is *creative*, a science is *analytical*.

When the artist paints a picture—say, a landscape—he is not merely putting on his canvas a copy of what he and anyone else can see. One has only to walk round the National Gallery to realise this. There you will sometimes find the same landscape painted by different artists. But somehow the pictures don't look both the same. You cannot tell exactly where the difference comes in, but you realise that there *is* a difference. The objects are the same, but somehow the "feel" of the two pictures is different. In other words, each picture has its own "individuality," and that individuality belongs to its painter and to no one else.

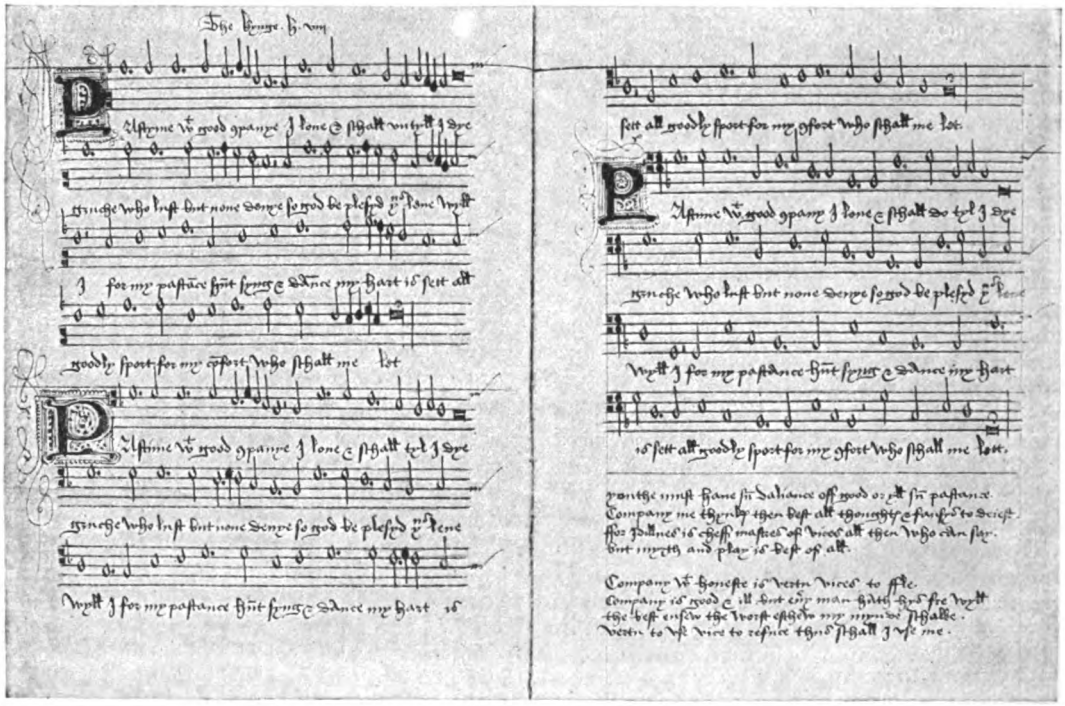
It is this individuality, this seeing the same things in a new and different light from others, that makes the picture an original creation, and not a copy of something else. In this sense Art is creative.

Two composers, likewise, may set out to describe in music the march of an army. Neither will write the same music, but the listener's military instinct will be stirred equally by both.

The scientist, on the other hand, takes things as they already exist and endeavours to reduce to rule the laws which govern them. This "taking of things to pieces" in order to find out the principles on which they have been put together is what we mean by "analysis." The musical composer uses certain notes, scales and chords. The science of music consists in "taking to pieces" or analysing these notes, scales and chords, and reducing to rule the composer's use of them. By this process we get what we call the theory, or the grammar, of music, just as we get the grammar of our language from reducing to rule the use of words and phrases by our great authors.

Just as the language of any nation creates the grammar, so have the works of the great composers created the grammar—or theory—of music. It is necessary to insist on this point, because so many musical text-books give the impression—if they do not actually state it outright—that certain "rules" for the composition of music have always existed (we have seen that even Ruskin thought something of the sort), and that all music must be written according to those rules. Really the rules are always changing; there are no set rules.

R. R. T.



A SONG COMPOSED BY KING HENRY VIII. (1509-47),

who, in common with the other Tudor monarchs, was a loyal patron of the Art of Music and a talented musician. The Tudor period was the golden age of English music as well as of the English drama.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—I

1. Arithmetic is the science of numbers, and investigates their relations and the operations to which they are subject.

A **Unit** denotes a single object considered as a whole. Thus a horse, a tree, a ball are units; but a school is also a unit if we look upon it as a whole, although it is made up of many individuals.

Numbers indicate how many objects are considered, e.g. one horse, two trees, three balls, four schools. Here the numbers of objects considered in each case are respectively one, two, three, four; and thus one, two, three, four are called numbers.

Numbers which refer to some particular kind of unit are called **concrete.**

Numbers used without reference to any particular unit are called **abstract.**

Thus £3, 5lbs., 8 miles are concrete, while 3, 5, 8 are abstract numbers.

2. All numbers in Arithmetic are expressed by the figure 0 (called nought, or zero, or a cypher), which has no intrinsic value, and the nine significant figures 1, 2, 3, 4, 5, 6, 7, 8, 9, which denote respectively one, two, three, four, five, six, seven, eight, nine.

These figures are also called digits. The number one, represented by 1, is also called unity. Each of the numbers 2 to 9 is obtained by adding 1 to the number preceding it.

3. In order that we may not have to burden our memory with a separate symbol and name for each number, all numbers greater than nine are expressed in words by a systematic plan, called a system of **Numeration,** and symbolised by a system of arranging the above digits in definite positions with regard to one another; this is called the system of **Notation.**

When any of the figures 1, 2, 3, 4, 5, 6, 7, 8, 9 stands by itself, it expresses its simple value; that is to say, 5 expresses five abstract units, or five particular things. But if it is followed by another figure, or zero, it expresses as many tens as it would express units if it stood alone; thus, 53 expresses five times ten units and three units added to it, while 50 expresses five times ten units. Similarly, when a figure is followed by two figures, it expresses as many hundreds as it would express units if it stood alone; thus 532 expresses five times a hundred units together with three times ten units, and two units more; and so on.

Thus we see that any figure has two values: (i) its value as a digit which is recognisable by its shape, and which may be called its **intrinsic value,** and (ii) its value due to its position with regard to other figures—its **local value.**

In Arithmetic then, we proceed to the left from units to tens of units; from tens of units to tens of tens of units, which are called hundreds of units; from hundreds of units to tens of hundreds of units, which are called thousands of units; from thousands of units to tens of thousands of units; from tens of thousands of units to hundreds of thousands of units; from hundreds of thousands of units to thousands of thousands of units, which are called millions of units, and so on.

The successive numbers are:

10, ten, i.e. one ten of units and no more.
11, eleven, i.e. one ten of units and 1 more unit.
12, twelve, i.e. one ten of units and 2 more units.
13, thirteen, i.e. one ten of units and 3 more units.

Similarly:

14, fourteen	17, seventeen
15, fifteen	18, eighteen
16, sixteen	19, nineteen.

The next ten numbers are:

20, twenty, i.e. 2 tens of units and no more.
21, twenty-one, i.e. 2 tens of units and 1 more unit.

And similarly:

22, twenty-two	26, twenty-six
23, twenty-three	27, twenty-seven
24, twenty-four	28, twenty-eight
25, twenty-five	29, twenty-nine.

The next ten numbers are:

30, thirty, i.e. 3 tens of units and no more.
31, thirty-one, i.e. 3 tens of units and 1 more unit,

etc., till we come to 40 (forty), 50 (fifty), 60 (sixty), 70 (seventy), 80 (eighty), 90 (ninety). The largest number that can be expressed by two figures is 99. The next number to this is 100 (one hundred), which means ten tens, or one hundred, units.

Other numbers are similarly expressed.

For example, 134 is one hundred units, together with three tens of units and four units more, or as it is usually expressed, one hundred and thirty-four.

4. To write in figures any number expressed in words it is necessary to write down the figures representing the number of units of the different orders (i.e. units, tens, hundreds), and fill up vacant places with zero.

To write two hundred and ninety-three in figures, put 2 in the hundreds' place, 9 in the tens' place, and 3 in the units' place, i.e. 293.

To write nine hundred thousand and forty-two in figures, put 9 in the hundred thousands' place, 0 in the ten thousands' place, 0 in the thousands' place, 0 in the hundreds' place, 4 in the tens' place, and 2 in the units' place, i.e. 900,042.

5. To express in words a number written in figures, divide the number into groups of three, beginning at the right (the last group on the left may be incomplete and consist of only one or two figures), then read each group beginning at the left, remembering that the second group from the right are thousands, the third and fourth groups are millions, etc.

To express in words 1561230826395. first divide it into groups of three thus, beginning at the right 1,561,230,826,395. It is then read off, one billion, five hundred and sixty-one thousand two hundred and thirty million, eight hundred and twenty-six thousand, three hundred and ninety-five.

Exercise 1

Express in figures:

1. Four hundred thousand.
2. Four hundred and thirty-seven.
3. Four thousand and thirty-seven.
4. Four hundred thousand and thirty-seven.
5. Four million, three thousand, seven hundred.
6. Nine thousand and nine.
7. Twenty-eight million, seven hundred and forty-three thousand, nine hundred and thirteen.
8. Two hundred and two million, two hundred and two thousand, two hundred and two.

Express in words:

9. 703. 10. 7003. 11. 700003. 12. 59047653.
13. 4321987650. 14. 897897897897.
15. 69743582211005. 16. 11000011000011.

The above is known as the **Arabic** system of notation. We must next describe the **Roman** system of notation.

6. Roman Numerals.—The **symbols** by means of which the Romans expressed numbers are the following:

I for 1, V for 5, X for 10, L for 50, C for 100, D for 500, and M for 1,000.

A horizontal line over any numeral increases its value a thousandfold, thus $\overline{X}$ stands for 10,000.

The numerals are arranged in order of magnitude from left to right, and are repeated as often as necessary.

Thus 2 is written II, 30 is written XXX; MCCCXXIII stands for 1,323, etc.

To avoid too many repetitions a numeral is sometimes placed on the left of another to denote that the value of the larger on the right is diminished by the value of the smaller on the left.

Thus IV represents 1 less than 5, that is 4. XC denotes ten less than a hundred, i.e. 90. CIↃ, CCIↃↃ, CCCIↃↃↃ, etc., originally denoted 1,000, 10,000, 100,000 respectively, etc.; and IↃ, IↃↃ, IↃↃↃ, etc., originally denoted 500, 5,000, 50,000, etc.

TABLE OF ROMAN NUMERALS

I	denotes	1	LX	denotes	60
II	,,	2	LXX	,,	70
III	,,	3	LXXX	,,	80
IV	,,	4	XC	,,	90
V	,,	5	C	,,	100
VI	,,	6	CC	,,	200
VII	,,	7	CCC	,,	300
VIII	,,	8	CCCC	,,	400
IX	,,	9	D	,,	500
X	,,	10	DC	,,	600
XI	,,	11	DCC	,,	700
etc.					
XX	,,	20	DCCC	,,	800
XXX	,,	30	DCCCC	,,	900
XL	,,	40	M	,,	1000
L	,,	50			

Exercise 2

Write in Roman numerals the following numbers: (1) 17. (2) 593. (3) 101. (4) 89. (5) 454. (6) 1763. Write in figures the following Roman numerals: (7) XIV. (8) XXXVIII. (9) CCXLV. (10) LXXII. (11) DCL. (12) MDCCCLXIX.

Addition

7. To add two or more numbers is to find a number which shall contain as many units as the original numbers together contain. Numbers to be added must be either abstract or else concrete numbers of the same kind.

The number found by adding two or more numbers together is called the *sum* or *amount*.

Addition is **simple** when the numbers to be added are abstract, or when they are all concrete numbers of the same denomination, such as all pence, or all pounds, or all feet.

Addition is **compound** when the numbers are concrete numbers of the same kind, but of different denominations such as: pounds, shillings and pence; or miles, yards, feet and inches.

8. The sign +, **plus,** placed before a number means that this number is to be added: thus $3 + 4 + 8$ means that 4 is to be added to 3 and that 8 is to be added to their sum.

The sign =, **equals,** placed between two numbers means that the two numbers are equal to each other.

The sign $\therefore$ means "therefore," and the sign $\because$ means "because."

The sign $>$ means "is greater than," and the sign $<$ means "is less than."

9. It is clear that $3 + 5$ is the same as $5 + 3$, i.e. $3 + 5 = 5 + 3$. In other words: A whole is the sum of all its parts taken in any order.

Thus we may vary the order, and to add 5 and 3 we may split up 3 into its parts, 1 and 2; then 5 and $3 = 5 + 1 + 2$, but $5 + 1 = 6 \therefore 5 + 1 + 2 = 6 + 2$. Again 2 is 1 and 1 $\therefore 6 + 2 = 6 + 1 + 1$, but $6 + 1 = 7 \therefore 6 + 1 + 1 = 7 + 1 =$ **8.**

The following table will prove useful to the student, who should prove it and learn it by heart. The number on the left is the sum of the various pairs of digits on the same line with it on the right. We have not included 1 or 0 in this, though both occur in actual addition, because adding

1 to a digit is a matter of definition, § 2; and adding 0 to a digit does not alter it.

4	2 & 2			
5	2 & 3			
6	2 & 4	3 & 3		
7	2 & 5	3 & 4		
8	2 & 6	3 & 5	4 & 4	
9	2 & 7	3 & 6	4 & 5	
10	2 & 8	3 & 7	4 & 6	5 & 5

10. To add 8976, 743, and 21.

Write down the numbers one under the other so that the units may come under units, tens under tens, etc. Then draw a straight line under the lowest.

```
 8976
  743
   21
 ----
 9740
```

The sum of 1 unit and 3 units and 6 units is 10 units: thus we must place 0 under the column of the units, and carry on the 1 ten units to the next column.

The sum of 1 ten and 2 tens and 4 tens and 7 tens is 14 tens, that is 10 tens and 4 tens; so we place 4 in the column of the tens and (since 10 tens = 100 units) we carry on the 1 to the next column.

The sum of 1 hundred and 7 hundreds and 9 hundreds is 17 hundreds, that is 10 hundreds and 7 hundreds; so we place 7 in the column of the hundreds and (since 10 hundreds = 1000 units) we carry on the 1 to the next column.

Again, the sum of 1 thousand and 8 thousands is 9 thousands; we therefore place the 9 under the column of the thousands.

In actual working we should proceed in the following way: 1 and 3 are 4, 4 and 6 are 10; put down **0** and carry 1; 1 and 2 are 3, 3 and 4 are 7, 7 and 7 are 14; put down **4** and carry 1; 1 and 7 are 8, 8 and 9 are 17; put down **7** and carry 1; 1 and 8 are **9**.

We will illustrate the working by one more example. Add 9740, 5479, 332 and 68.

We may work this by giving each figure its full local value.

```
9740 =  9000 +  700 +  40 +  0
5479 =  5000 +  400 +  70 +  9
 332 =        +  300 +  30 +  2
  68 =                 60 +  8
```

Adding the columns we get the sum

$= 14{,}000 + 1400 + 200 + 19$

$= 14{,}000 + (1000 + 400) + 200 + (10 + 9)$

for $1400 = 1000 + 400$ & $19 = 10 + 9$

Collecting the thousands, hundreds, etc., together

$= \mathbf{15{,}619}$.

To test the result of any addition sum, add the columns first upwards and then downwards. The resulting sums should agree. A further test of accuracy will be given later.

Exercise 3

Add together—

(1) 4789, 2346, 3857, 5005.

(2) 4976352, 278, 59431, 76543.

(3) 81726354, 762153, 910562318, 321, 5678, 7, 29, 400.

(4) Find the sum of 935473, 262, 13897, 598453, 25, 3734, 724008, and 649768.

(5) Add together the numbers in the rows, columns, and oblique lines—from corner to corner—of the following squares:

(*a*)

1	15	14	4
12	6	7	9
8	10	11	5
13	3	2	16

(*b*) (From De Morgan's "Elements of Arithmetic")

2016	1212	1656	3852	1296	3492	936	3132	576	2772	216
252	2052	1248	1692	3888	1332	3528	972	3168	612	2412
2448	288	2088	4284	1728	3924	1368	3564	1008	2808	648
684	2484	324	2124	4320	1764	3960	1404	3204	1044	2844
2880	720	2520	360	2160	4356	1800	3600	1440	3240	1080
1116	2916	756	2556	396	2196	3996	1836	3636	1476	3276
3312	1152	2952	792	2592	36	2232	4032	1872	3672	1512
1548	3348	1188	2988	432	2628	72	2268	4068	1908	3708
3744	1584	3384	828	3024	468	2664	108	2304	4104	1944
1980	3780	1224	3420	864	3060	504	2700	144	2340	4140
4176	1620	3816	1260	3456	900	3096	540	2736	180	2376

(6) Perform the following additions:

(*a*)	(*b*)	(*c*)	(*d*)
259401	23	705091	1101107752
74639	654	4	9851075636
290	100101	2103	4988766
7	1342	57	40013
39412	4136587	9015691	46135792
	49028	8501273	121033750
		6421	

M. A. L.

ALGEBRA.*—I

1. When we work out an arithmetical problem, there is always one part of the work which is special to the particular concrete case we are considering, but there is also one part which is general and is applicable to all cases.

For instance: A man gives a party; in each of three rooms there are eight guests, and in a fourth room there are five guests. How many guests are there altogether?

We should discover how many guests there were by setting out the problem in the following way:

$$3 \times 8 + 5 = 29.$$

**Note.*—The student who is not thoroughly familiar with Arithmetic is advised to postpone his study of Algebra until he has worked through the course in Arithmetic, at least as far as and including the lessons on Fractions, Decimals, and Roots.

Now the figures 3, 8, 5 and 29 are special to the particular concrete case we are considering. But the symbol =, and the symbols of operation ×, + have the same meaning whatever the figures are, and moreover, the laws which the symbols of operation follow are independent of the particular figures. Also the actual meaning of 3, 8, 5, 29 is independent of whether we are counting people in rooms, or oranges in boxes, or eggs in baskets.

Thus we see that a particular arithmetical problem has a general aspect as well, and it is with this general aspect of arithmetic that Algebra deals.

But we may generalise our problem further.

Instead of considering three rooms with eight guests in them, we may consider any number of rooms, say a (where a stands for any value we like to assign to it, *e.g.* 3, 9, 27, 50, and so on); further we may consider that there are any number of guests, say b, in each room (where b stands for any value we like to assign to it); and, lastly, the number of guests in the last room may be any number, say c (where c stands for any value we like to assign to it). Then, if d stands for the total number of guests, we have, by the same use of the symbols of operation as in the particular case,

$$b \times a + c = d.$$

We have thus arrived at a **general formula** or **algebraic formula,** by which we may solve any problem of this kind, by merely substituting for a, b, and c the values suitable to a particular case and carrying out the operations indicated by the symbols. The value of d will of course vary according to the particular values of a, b, and c.

Thus if we have the following problem: A man has six baskets of eggs, five of which each contain 24 eggs, and the sixth contains 30 eggs. How many eggs has he altogether? For a we substitute 5, for b we substitute 24, and for c we substitute 30. Then by carrying out the operations indicated by the symbols × and + we shall find the value of d.

Hence our general formula

$$b \times a + c = d$$

becomes $24 \times 5 + 30 = \mathbf{150}$.

In Algebra we use letters to represent any numbers whatever, and consequently the results we arrive at are true for all numbers.

2. For the present the student may regard the symbols of operation +, −, ×, ÷ as having the same meaning as in arithmetic; later on we shall see that their meaning may be extended. He may also, to assist him, think of the letters we use, called **operands,** as referring to definite concrete quantities, such as sums of money, lengths of lines, areas, and so on; but he must realise that these operands measure the number of times which any particular unit is contained in the concrete quantity he is dealing with.

Thus he may take a to mean a certain number of shillings: in that case a indicates the number of times which the unit one shilling is contained in the sum we are dealing with, or to put it differently, a denotes the quantity of shillings in the sum we are dealing with.

Hence we see that our operands, whether they be figures or letters, always represent numbers or quantities.

3. The symbol for **Addition** is +, and is read **plus.**

Thus, just as $5 + 7 + 2$ means that 7 is to be added to 5, and then 2 added to their sum, so $a + b + c$ means that b is to be added to a, and then c added to their sum.

The symbol for **Subtraction** is -- and is read **minus.**

Thus as $7 - 3 - 2$ means that 3 is to be subtracted from 7, and then 2 subtracted from their difference, so $a - b - c$ means that b is to be subtracted from a, and then c subtracted from their difference.

Similarly $a - b + c$ means that b is to be subtracted from a, and then c added to their difference.

For **Multiplication** the symbol is ×, and is read **multiplied by.** When there can be no ambiguity the × is usually omitted, and the multiplicand and multiplier are written close together. Thus ab means $a \times b$; and $6a$ means $6 \times a$; and $5abc$ means $5 \times a \times b \times c$.

The student should notice that the × cannot be omitted between figures, for $13 = 10 + 3$, and is not the same as 1×3.

A further means of indicating multiplication is to place a dot as low as possible between the figures or letters. Thus $a.b.c.$ means $a \times b \times c$; and $2.3.4$ means $2 \times 3 \times 4$.

It is necessary to exercise care in placing the dot low, as otherwise it may be confused with the decimal point; 2.5 means 2×5, but 2·5 means $2 + \frac{5}{10}$.

We may read $a \times b$ not only as "a multiplied by b," but also as "the product of a and b," or "the product of a into b." Hence by a natural contraction $a \times b$ is often read "a into b." The multiplicand a and the multiplier b are often spoken of as the **factors** of the product.

For **Division** the symbol ÷, read **divided by,** is used.

$a \div b$ means "a divided by b," or "the quotient of a by b," where a is the dividend and b is the divisor.

Other ways of writing this are $\frac{a}{b}$ or a/b or $a : b$, but these are not equivalent in every case to ÷.

$a \div b \div c$ means that a is to be divided by b and then the quotient is to be divided by c.

$a \div b \times c$ means that a is to be divided by b and then the quotient is to be multiplied by c.

$a \times b \div c$ means that a is to be multiplied by b and the product is then to be divided by c.

Thus we see that,

In Multiplication and Division the order of operation is from left to right.

If we take an example with figures the student will see the importance of establishing a convention of this kind.

If $a = 12$, $b = 4$, and $c = 2$,

$a \div b \times c = 12 \div 4 \times 2$.

Now $12 \div 4 = 3$ and $3 \times 2 = 6$.

But if we do not commence with the operator on the left, and begin instead with the one on the right, we have:

$$4 \times 2 = 8 \text{ and } 12 \div 8 = 1\tfrac{1}{2}.$$

We get, as is seen, a totally different result.

4. It is clear that the operations of **Addition** and **Subtraction** are **inverse;** that is to say, that if we first add a quantity and then subtract it, or if we first subtract a quantity and then add it, the result is the same as if we had performed no operation at all.

Thus $a + b - b = a$ and $a - b + b = a$.

In exactly the same way **Multiplication** and **Division** are **inverse.**

Thus $a \times b \div b = a$ and $a \div b \times b = a$.

5. We have already said that $3abc$ is the **product** of the **factors** 3, a, b, c.

Now if the factors are divided into two sets, the one set is called the co-factor, or more usually the **coefficient** of the other.

Thus 3 is the coefficient of abc; $3a$ is the coefficient of bc; $3ab$ is the coefficient of c; $3ac$ is the coefficient of b; and so on.

6. When a product consists of the same quantity repeated as a factor any number of times, that product is called a **power** of the quantity.

3×3 is written 3^2, and is called the second power of 3, or 3 square.

$a \times a$ is written a^2, and is called the second power of a, or a square.

$3 \times 3 \times 3$ is written 3^3, and is called the third power of 3, or 3 cube.

$a \times a \times a$ is written a^3, and is called the third power of a, or a cube.

$3 \times 3 \times 3 \times 3$ is written 3^4, and is called the fourth power of 3, or 3 to the fourth.

$a \times a \times a \times a$ is written a^4, and is called the fourth power of a, or a to the fourth.

And in general, $a \times a \times a \times a \times \ldots\ldots a$ (n factors) is written a^n, and is called the nth power of a, or a to the nth.

Here n stands for any arithmetical integer or whole number. a is called the **base of the power,** and n is called the **index,** or **exponent of the power.**

The operation of raising any quantity to a given power (i.e. finding the product of that quantity taken a given number of times as a factor) is called **Involution.**

The quantity whose n^{th} power is a is called the nth **root** *of* a, and is written $\sqrt[n]{a}$.

The operation of deriving $\sqrt[n]{a}$ is called **Evolution.**

The square root of a is written $\sqrt{a}$; the cube root of a is written $\sqrt[3]{a}$; the fourth root of a is written $\sqrt[4]{a}$, and so on.

$\sqrt{\ }$ is called the **radical** or **root sign.**

Now if $a = b^n$ where a and b are arithmetical numbers, it is clear that b satisfies the definition of $\sqrt[n]{b^n}$; and it also follows that the nth power of $\sqrt[n]{a}$ is a.

Thus we see that **Involution** and **Evolution** are also **inverse** operations.

We will illustrate this by actual numbers.

If $a = 16$ and $b = 2$ and $n = 4$.

$16 = 2^4$; 2 is the fourth root of 2^4, i.e. of 16;

$\sqrt[4]{16} = 2$; the fourth power of $\sqrt[4]{16}$ is the fourth power of $2 = 16$.

7. A root which cannot be obtained exactly is called a **surd,** or an **irrational** quantity, or an **incommensurable** quantity.

If we can find a number b such that $b^2 = a$, then $\sqrt{a}$ is a **rational** or **commensurable** number.

Thus if $a = 9$, then $b = 3$, since the square of 3 is 9. Then $\sqrt{9}$ (which is 3) is a rational or commensurable number.

But suppose $a = 5$, then we can find no number which when squared will $= 5$, and therefore $\sqrt{5}$ is an irrational or incommensurable number.

We may however always find a commensurable number which **approximates** to $\sqrt{5}$, and by taking a sufficient number of decimal places we can make this commensurable number differ from $\sqrt{5}$ by as small a quantity as we please.

8. A collection of algebraic symbols, i.e. of letters, figures, and symbols of operation, is called an **algebraic expression.**

The parts of an algebraic expression which are connected by the symbols + and − are called its *terms.*

Thus $2ax + 3by - 5cz$ is an algebraic expression, and its terms are $2ax$, $3by$ and $5cz$.

9. Terms which only differ in their numerical coefficients are called **like terms.** Thus $3x$ and $5x$ are like terms; $7a^2b^3c$ and $15a^2b^3c$ are like terms. But $3x$ and $5y$ are unlike terms; and $7ab^2c$ and $15a^2b^3c$ are unlike terms, because though the letters are the same, different powers of them occur in the two terms.

10. An expression containing only one term is called **monomial;** an expression containing two terms is called **binomial;** an expression containing three terms is called **trinomial;** and an expression containing four or more terms is called **multinomial.**

11. The sign = means "equals," or "equal to."

The sign $>$ means "is greater than."

The sign $<$ means "is less than."

The signs $\neq$, $\not>$, $\not<$, mean respectively "does not equal," "is not greater than," and "is not less than."

The sign $\because$ means "because," and the sign $\therefore$ means "therefore."

12. To denote that any algebraic expression is to be treated as a whole, it is put into brackets. Thus $(a + b)c$ means that b is to be added to a, and the sum multiplied by c; $(a + b)(c - d)$ means that the sum of a and b is to be multiplied by the difference of c and d; $(a + b)^3 \div (c - d)^2$ means that the cube of the sum of a and b is to be divided by the square of the difference of c and d.

Exercise 1

Find the numerical value of the following expressions when $a = 1$, $b = 2$, $c = 3$ and $d = 4$.

(1) $7a - 2b + c + 4d$. (2) $9a + 7b - 5c - 2d$.
(3) $20a + bc - d$. (4) $ab + bc + cd$. (5) $3ad - bc$.
(6) $5ac + 2b - 4ad$. (7) $bc - ca - ab$.
(8) $abc + bcd + cda$. (9) $a + bc + bcd + abcd$.
(10) $5abcd - 2abc + 3bcd - abd$.

Find the numerical value of the following expressions when $a = 3$, $b = 1$, and $c = 2$.

(11) $3a^2 - 4b^2c$. (12) $2a^3b - 4bc^2$. (13) $\frac{b^2}{4} + \frac{ac}{12}$.
(14) $a^2 + 3ac^3 - 10b^2c + b^4$.

Find the value of the following expressions when $a = 5$, $b = 4$, $c = 1$, and $d = 2$.

(15) $3a^2 + \frac{1}{a^2 - b^2}$ (16) $3a^2 + \frac{1}{a^2} - b^2$.

M. A. L.

BUSINESS AND COMMERCE:

***Contributors*:**—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—I

BUSINESS and Commerce—what a multitude of aims and ambitions, of duties and tasks, are included in these two words!

Business and commerce—the science and art of earning a livelihood to the best of one's ability; of making progress; of pushing up life's ladder.

The pity of it all is that so few beginners in offices realise that they are merely learners, apprentices and undergraduates. In what I may term the learned professions the aspirant works through a course of lectures and instruction at a university or else becomes an articled pupil. Doctors serve for years at a medical college and hospital. The clerk does not require a set of initials after his name to be a keeper of petty cash; whilst the office-boy is master of his own duties within a few days of his appointment.

Preparing for Promotion

As the outcome of this feeling of knowing so well the particular task of the day there arises a totally false impression. A doctor with the receipt of his degree is a master of his profession, and when a solicitor has taken his certificate he may practise. A junior clerk, however, because he knows the points of his immediate post so well is not a *master* and must take steps himself to graduate for a position as senior clerk, departmental manager and general manager. Whilst he is a junior clerk, he must perform the duties of that post to the very best of his ability, but all the time he must be preparing himself for advancement. He must become a master, not of junior clerkship, but of business and commerce in its broadest sense.

This sacrifice of leisure is the price to be paid for going out into the world as a wage-earner at sixteen years of age, and of gaining one's knowledge and power as a paid servant and not as a paying student.

To begin at the very basis of all business, it is necessary first thoroughly to understand the purposes and objects of that brain, heart and hub of business and commerce, the office.

Let us for a moment imagine some great, wide-spreading business engaged in the production of a much-used commodity. The huge office with its many departments is closely in touch with the factory, and there are smaller branch offices in many towns.

What exactly is the work of the main office, and how are its duties subdivided?

In the first place, there will be a buying department, to deal entirely with the purchase of all the raw materials required. There will be a selling department, for the disposal of the wares. A stock department will be responsible for all stocks, whether of raw materials or finished goods. A correspondence department will look after the dispatching and filing of letters; and there will be a department in which the book-keepers and accountants will do their work, besides a cashiers' section. In all probability there will also be a factory department, in which the workers' wages, costs, and all such matters will be taken charge of.

Office Contrasts

Each of these departments will have its own head, possibly a director in the case of a limited liability company, and the chiefs will confer at periodical meetings, whilst over them all will be the principal of the business, the managing director or the general manager.

Now take the exact opposite in offices, that of a practising solicitor. Here there will be a junior for press-copying letters, running messages and performing other duties; some clerks for keeping accounts and the copying and engrossing of legal documents; one or more shorthand-typists;

one or more articled clerks; a qualified solicitor who will act as manager or deputy, and the solicitor himself or the partners.

But between these two extremes in offices you may find a hundred and one varying types. Take a railway company, for example, with a big headquarters office. Here the head will be the General Manager, and under him the Superintendent of the Line, Goods Manager, Chief Accountant, Secretary, Chief Cashier, Engineers, Publicity Manager and a host of minor departments.

Then there are non-producing businesses, such as banks, insurance companies and the like, with totally different office systems, though all must be departmentalised, for in every business, great or small, there must be departments, each in charge of a head.

Making Departments Pay

To define the work performed in offices would be wellnigh impossible, but there is a great deal of labour beyond the mere keeping of accounts and the writing and filing of letters. For example, in offices attached to factories and works the costing clerks are of the utmost importance in conducting the business on efficient commercial lines. With the aid of returns from the costs department and an analysis of a particular class of goods a manager could tell to the fraction of a farthing precisely what the most minute detail worked out at in price; whilst in motor factories—to quote a further example—the cost of each trifling fitting is calculated to the uttermost place of decimals. Thus, by arriving at the prime cost of goods, the margin of profit becomes so absolutely definite that quotations and estimates may be made with automatic precision.

In the case of offices conducted by a business with many subsections or side-lines, a system pertains of analysing the accounts so that each section may bear its proportion of the charges of the establishment. Thus, in a departmental stores, for instance, the charges for rent, rates, taxes, lighting, general wages and similar outgoings would be lumped together and subdivided amongst all the departments in accordance with their relative business value.

Registered offices of limited liability companies are compelled by law to comply with certain regulations. For instance, the actual address of the office has to be registered at Somerset House, London, in the case of English offices, whilst Scotland registers in Edinburgh, Ireland at Dublin. The secretary of such a company must keep minutes or notes of both directors' and shareholders' meetings, and there are certain returns he must make periodically to the Government as to the position of the company. He alone is responsible to the authorities for the regular delivery of the information that must be made public by all companies under the Limited Liability Acts.

In large offices, where there is sufficient business to justify such a course, the actual handling of cash and cheques coming in falls to one section of the cashier's department, whilst the outgoing amounts are dealt with by a second and totally separate section.

In the vast majority of offices boys begin their careers as junior clerks by press-copying letters, attending to the telephone, making transcript copies of documents, "calling" figures to clerks above them, and so on.

Girls have taken their place very definitely as painstaking, keen office workers, and in recent years many women have risen to hold most responsible positions. Naturally, it is in the direction of secretarial work, which embraces shorthand and typewriting, that girls shine most, but members of the fair sex are largely engaged now in the filing of letters, the keeping of returns and accounts, and in other purely clerical tasks.

Clothes may not seem a very important matter to those who work in offices. As a matter of fact, however, they have a bearing upon the impression formed in the minds of managers, and after all it is that way that promotion lies. A man or woman who is tidy in person is usually methodical in work.

Meeting the Opportunity

To sum up the qualities of a successful office worker, I should say he must know his own work most thoroughly, possess a working knowledge of the duties of the man above him and a fair insight into the conduct of the business in which he is engaged.

And not only should a clerk do all that lies in his power for the maintenance of his particular post, but he must intelligently anticipate the next post he may be called to, and the one after that again.

In the world of commerce, as in the wider universe, things are not allowed to go drifting along just as they were. All the time, almost unapparent to those closely in touch with the movement, there is evolution, development, improvement, progress.

Therefore, every clerk in every office should primarily do his own work better than anyone else could do it, and he should strive to become a creator, a worker who can advance the interests of those who employ him.

A. B.

CHOOSING A CAREER.—I

WHAT shall I become? To what calling can I put my son or daughter?

These, and scores of kindred questions, are asked every day either by prospective workers or by their parents, and it is to render easier the task of answering them that this series has been prepared.

In the first instance, the series will deal with the great "group" callings, commencing with agriculture and its ramifications, passing next to emigration, and proceeding then to examine the many kinds of Government employment and municipal service.

We shall then deal with the professions—the Church, law, literature, music, medicine, education, and the like. Then the railway world, with its multitude of opportunities, and the sea will be dealt with, to be followed by purely commercial callings and a special section on work for women.

Finally, we shall study a comprehensive alphabetical list of other trades and callings which do not come under any of the above headings.

At the same time it must be borne in mind that though in this series the truth about every calling will be faithfully presented, the selection of a trade or profession must necessarily depend very largely upon purely personal attributes.

So far as is possible, the natural bent and inclinations of the young worker should guide his or her decision. Therefore, although parents, guardians, and other advisers should carefully study a selection of callings suitable for those in their care to follow, the decision—the casting vote at any rate—should remain with the young men and women themselves.

* * * * * *

Agriculture.—At no time in our history have there been greater inducements for men and women to take up farming than there are at present. The calling itself plays one of the most important parts in national reconstruction and the demand for home-grown produce, more particularly corn and live-stock, has altered to a marked degree the old outlook upon agriculture.

Wages recently have been very nearly doubled to the labourer; housing is receiving close attention from the authorities; the price to the producer ensures that the raising of stock and foodstuffs is profitable, and there is apparent on every hand a keener appreciation for the necessity of a more intensive use of our great natural resources. Moreover, though not generally realised, it is a fact that there are in this country more people engaged in agricultural work than in any other calling, despite the wonderful increase in our manufacturing trades.

This article deals only with the farmer proper, the man who works from eighty to eight hundred acres of good, rich land, as opposed to small-holders, fruit farmers and market gardeners.

Even the big farmers, however, may be subdivided into many classes. First, there is the mixed farm, on which both stock and grain are raised; there is the big down farm, principally pasturage; there are farms without much livestock, that are devoted to the growing of corn, roots and other products. Generally speaking, however, it is the mixed farm that prevails, and to be successful with such a holding a man requires undoubted scientific knowledge, considerable business acumen, an organising brain and a fund of great application.

People who have not probed very deeply into the subject have no conception of the specialist's knowledge required by a farm worker. Agriculture is not only our most important, it is also our oldest industry; we have all become so used to the familiar sights and scenes of the country-side that few of us appreciate that this is a calling in which only those who absolutely master their trade—a trade with countless intricacies—can hope to succeed.

It follows, therefore, that the education of a farmer must be of a thoroughly practical nature. He must have actual, personal, working knowledge of all the arts and crafts associated with his profession, and the farmer who rides round his fields on a sturdy cob must be able not only to direct, but also to criticise and inspire from a definite, personal acquaintanceship with the task in hand.

One of the most successful farmers in the South of England once informed me of the steps by which he had attained success. He began as a boy on a farm in Somersetshire, where he remained two years studying the methods of that particular county; then he migrated northwards to the Pickering district of Yorkshire, where he lived round the year. Shropshire saw him next for two seasons, and then for one year he studied in Middlesex, quite near to the Metropolis. Eventually, he settled down on a farm of his own where he brought to bear all the diverse knowledge obtained in so many directions and there made his mark.

The young man who wishes to take up farming must serve an earnest apprentice-

HEALTH OR WEALTH?

Our artist has depicted representatives of various trades and professions in their relative positions on the steps of the Temple of Health. The figures show the health standard of persons, between the ages of 23 and 65, engaged in these occupations, 1,000 being taken as the basis. It will be noted that the clergyman stands at the top, and the general labourer at the bottom; the position of the miner is perhaps surprisingly high.

ship to the life. In certain cases farmers charge a premium for pupils, usually not a high one, but a willing, eager lad can usually serve an apprenticeship to his craft and pay for the privilege only with honest toil. Indeed, there are farmers only too pleased even to pay wages (small, of course) to beginners.

In this *practical* way young farmers will become acquainted with horses, cattle, sheep, pigs, poultry, and all the other stock; with sowing, ploughing, mowing, reaping, harrowing and the many phases of cultivation and harvesting; with manures and fertilisers; with hedging and road-making; with motor tractors and similar appliances. This sound, first-hand practical knowledge, especially if a smattering of market lore and the arts of buying and selling can be gleaned, will stand them in good stead all their lives.

At the same time, the *theoretical* aspect must not be neglected. Farming is on the fringe of chemistry, mechanics, botany and kindred learned subjects. Every young farmer, therefore, should educate himself to appreciate the chemical changes in soil, the action of farmyard manures, and the science of artificial fertilisers that are designed to make up for Nature's shortage of any particular material. There is theory, too, about live-stock to be acquired; mechanical theory concerning internal combustion engines; theory of keeping accounts; of the rotation of crops, and in many other directions.

There are many winter season classes, partly financed by our Board of Agriculture, that may be attended by a budding farmer anxious to obtain the theoretical knowledge of his calling. Under the County Councils there are farm schools, dairy schools and agricultural institutes where students are taught for almost nominal fees, and by making application to any County Council, addressing the inquiry to the secretary at the county town, full particulars of any existing classes would be forwarded.

In addition, there are the *University Colleges of Aberystwyth, Bangor, Leeds, Newcastle* and *Reading* where agriculture is taught, in some cases actually at a college farm, whilst the *University of Cambridge* has also a farm school. In fact, some of the universities grant both diplomas and degrees in this subject; and in no case are the fees of an exorbitant standard. Full particulars of all these courses may be obtained by making written application, addressing the inquiry in the case of the colleges to the principal.

In addition to these courses and classes, there are, scattered up and down the country, schools and colleges where a lad may go and be taught both the practical and the theoretical side of farming. There is, for instance, the *Agricultural College at Aspatria*, Cumberland, near Carlisle, where scientific and practical instruction is given to future farmers, land agents and owners, as well as to intending colonists. At this college access is given to no fewer than 2,000 acres of highly-farmed land.

Then there are: *The Royal Agricultural College at Cirencester*, under the Bristol University, with about 500 acres; *the College of Agriculture and Horticulture at Holmes Chapel*, Cheshire, affiliated to the Manchester University; *the Midland Agricultural and Dairy College*, Kingston, Derby; the *Harper-Adams Agricultural College*, Newport, Shropshire; *the Agricultural and Colonial College*, Tamworth, Staffordshire; and the *South-Eastern Agricultural College* at Wye in Kent.

Each of these colleges—and their number is continually increasing—cater for young men who will either live on the premises or near by, and who will go through the term or year just as they would do at any other seat of learning. At the same time, most of the colleges also provide for those who cannot attend by the term or year but who want a course of theoretics that may be covered in the space of a few weeks. Details may always be obtained on application to the respective principals.

But, above all the knowledge and learning and also experience, the would-be farmer must consider carefully the question of his capital. It is an expensive matter to start a farm, and a young man had far better remain a paid servant a year or two longer than launch out into independence without sufficient funds.

A capital of from £20 to £30 per acre for mixed farming is none too much, and young farmers must remember that there will be little or nothing coming in for many months, but that money will be passing outwards at an alarming rate all the time. And there is always a bad season to be reckoned with.

Those who would farm, therefore, must bear in mind that they will have more knowledge to acquire than they would be called upon to possess in any other calling, knowledge to the attainment of which they must be prepared to give a due allowance of their time in youth.

A. C. M.

BOOK-KEEPING.—I

BOOK-KEEPING is a subject which becomes increasingly important. It occupies a prominent place in the programme of all the public examining bodies, and without it business on any but the very smallest scale would be impossible.

The object of these lessons is to meet the requirements of those intended for a business career, by enabling them to grapple intelligently with the problems of commercial work, and to attain that proficiency which is represented by success in public examinations.

Book-keeping has been described as "the art of recording business transactions with a view of having a permanent record of them and of showing their effect upon wealth." The small shopkeeper who quite unconcernedly puts his money into his till, entering only the total at night in a small pocket-book, in which he also makes a record of his daily payments, is in some measure a book-keeper; but his crude system—if system it may be called—is altogether inadequate for present-day requirements.

The only real and satisfactory system of book-keeping is that which enables a trader to answer the following questions:—

(1) How much do I owe to others?
(2) What do others owe to me?
(3) Is my business profitable or otherwise?
(4) What is the extent of my gain or loss?
(5) What is the full extent of my capital or deficiency? In short, What is the position of my financial affairs?

The only system of book-keeping by which all this information can be secured is that known as **Double Entry** which, in addition to giving the particulars, enables the accuracy of the results to be proved.

Our definition of book-keeping may be re-cast as follows: Book-keeping is the science and art of recording all those transactions in business involving the transfer of money or its worth, in such a way that the accuracy of the results may be proved and the financial position of the trader ascertained at any moment.

Every business transaction has a double effect, and that double effect is recorded in books which are kept on the double entry principle.

Suppose I buy a cow from a local farmer, John Barley, but I do not pay for it at the time of purchase. What happens? Simply this: that I have received an addition to my livestock, and in my books I must make a record of this addition. Besides this, I owe Mr. Barley for the cow, and this indebtedness I must show in my books. Supposing, however, I paid cash to Mr. Barley for the animal, in that case his name need not be recorded in my books, because I am not indebted to him. But something has gone from my cash, and if I do not show this in my books the record will be incomplete. The net result of the transaction will be that there has been an addition to my livestock and a diminution of my cash, and this double effect of the one transaction must find its record in my books.

To take another case. I sell to a city trader a parcel of wheat for £100. If I am to show this transaction properly I must record not only that the wheat has left my possession but that the city trader owes me for it. If and when he pays me the amount I must show that he has given me cash, and thus liquidated his indebtedness.

When I pay money away, my records must show not only that the money has gone from me, but the name of the person to whom or the purpose for which it has been paid.

If the student will from the very outset keep in mind this twofold effect of every transaction, he will be relieved from much confusion.

We are now in a position to discuss the terms **Debit and Credit** which are at the very foundation of all account-keeping. Their meaning can perhaps be best grasped by remembering that:

(*a*) A Debit applies to that which is received, or to a loss.
(*b*) A Credit applies to that which is given, or to a gain.
(*c*) All Debits must have corresponding Credits.

If I buy goods from James Dealer, I *receive* goods, and my Goods Account is debited. James Dealer *gives* or *parts with* the goods, and therefore he must be credited. If I pay Mr. Dealer in cash, my Cash Account must be credited. Mr. Dealer, being the *receiver* of the money, must be debited. In this way his transaction with me is closed, because his account shows an equal debit and credit. He was first of all credited with the amount of the goods, and afterwards debited with the same amount of cash.

If I pay away £100 for wages, my Cash Account will be credited with the amount paid, and Wages Account will be debited. Wages in this case will be looked upon as a loss, as the money paid does not bring me back an asset in a tangible form.

We propose to illustrate the true meaning and application of debiting and crediting

accounts by means of the Journal. This book is seldom or never used in practical work in the form shown, but its use as an introduction to the subject is valuable.

Let it be supposed that a man, whom we will call A. Venture, has commenced business, and that the following represent some of his transactions during the month :—

19..				£	s.	d.
Jan.	1	Commenced with Cash		500	–	–
„	2	Bought goods from W. LEES ..		150	–	–
„	3	Sold goods to F. SMITH		25	–	–
„	7	Paid cash to W. LEES		100	–	–
„	9	Bought goods from A. SHAW ..		37	10	–
„	15	Received cash from F. SMITH ..		20	–	–
„	21	Paid wages ..		10	–	–

These transactions would be entered in the books in various ways, according to the requirements of the particular business. We will suppose, however, that A. Venture has simply made a memorandum in the above form, intending it for the purpose of entering up his accounts in the proper books when opportunity offers. The above book would be technically described as a **Waste Book.**

We will proceed to enter these details in a double entry form in the Journal. Two accounts are affected by each transaction, and the effect may be set out as under.

The arrangement of this book explains itself, but below we give an exposition of some of the entries.

Jan. 1.—In this case cash is paid into the business by Mr. Venture, its owner. The Cash Account must therefore be debited, and Mr. Venture credited. It is usual to describe the account of the owner as the CAPITAL ACCOUNT.

Jan. 2.—Goods come in and are debited in the Purchases Account.

W. Lees parts with the goods, therefore he is credited.

Jan. 3.—F. Smith receives goods, therefore his account is debited.

Goods go out, and the Sales Account is credited.

Commercial Terms

In order that the reader may become acquainted with business terms, definitions of a few will be given with each lesson :

Assets : For book-keeping purposes a man's possessions and whatever may be owing to him are described as Assets.

Liabilities : Whatever may be owing by a person, or any payments which he is liable to make, would be described as Liabilities.

Capital : Is wealth invested by a trader in his business. It is the difference between what he has and what he owes ; in other words, the amount by which his Assets exceed his Liabilities.

A Debtor is a person who owes money to another.

A Creditor is a person to whom money is owing.

JOURNAL

19..				Led. fo.	Dr. £	Dr. s.	Dr. d.	Cr. £	Cr. s.	Cr. d.
Jan.	1	Cash	*Dr.*		500	–	–			
		To Capital						500	–	–
	2	Purchases	*Dr.*		150	–	–			
		To W. Lees						150	–	–
	3	F. Smith	*Dr.*		25	–	–			
		To Sales						25	–	–
	7	W. Lees	*Dr.*		100	–	–			
		To Cash						100	–	–
	9	Purchases	*Dr.*		37	10	–			
		To A. Shaw						37	10	–
	15	Cash	*Dr.*		20	–	–			
		To F. Smith						20	–	–
	21	Wages	*Dr.*		10	–	–			
		To Cash						10	–	–
					£842	10	–	£842	10	–

F. H.

SHORTHAND.—I

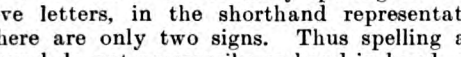
This Course of Lessons on Pitman's Shorthand is published by arrangement with Sir Isaac Pitman & Sons, Ltd., and has been specially compiled by them for this publication.

Introduction.—At the commencement of all studies there are certain important facts which must be kept in mind if success is to be gained. Pitman's Shorthand is no exception to this rule. First and foremost, the student must remember that in Pitman's Shorthand the underlying factor is *writing by sound*, and this must be constantly borne in mind, particularly in this lesson. Words are made up of consonants and vowels, as is well known by all. In Pitman's Shorthand the consonants and vowels *heard* in a word are the only ones represented. For example, in the word *queue*, the only sounds heard are the consonant *k* and *ū*, and whereas in the ordinary spelling there are five letters, in the shorthand representation there are only two signs. Thus spelling and sound do not necessarily go hand in hand, and the shorthand student must at once learn to analyse spoken words into their sounds.

For the working of the exercises and for ordinary shorthand writing, a pen and ruled paper should be used. As, however, it is not always possible to use a pen for notetaking, the student would do well to accustom himself to writing either with a pen or pencil in the more advanced stages of the study. The nib employed should not be too stiff, but should have a sufficiently fine and flexible point to enable the thick and thin characters to be written clearly and unmistakably. Paper with a fairly smooth surface is absolutely necessary.

As the secret of success in the art of shorthand is *practice*, the student is strongly advised to write and re-write the various exercises until they can be done with perfect freedom and accuracy.

The Alphabet.—The following eight signs represent the first eight consonants of the shorthand alphabet—



Notice that these are straight strokes, that they are written at different slopes, and that they are in pairs, one thin and the other thick. These signs represent the sounds of the consonants—

p, b, t, d, ch, j, k, g,

and in speaking of these consonants from the shorthand point of view, they are called

pee, bee, tee, dee, chay, jay, kay, gay.

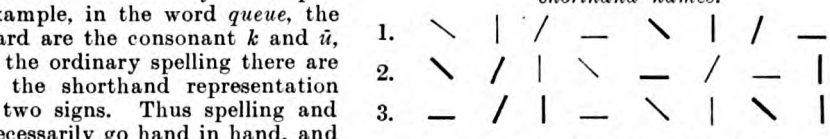
The signs are given in pairs because the pairs are sounded in a similar manner, but the first lightly and the second heavily. Hence the signs indicate the manner in which the sounds they represent are pronounced. Copy the signs carefully, remembering that the first three pairs are written downward, and the last pair from left to right, and whether light or heavy, the strokes must be written by one impression of the pen.

Exercise 1.

Pay special attention to *J* and *G*. The former is found in the words *joy, Joe, Jew, jay, edge ;* the latter in the words *go, gay, guy, egg ;* and both of them are found in *jog, jug, jig.*

Exercise 2.

Read the following signs giving them their shorthand names.



Key to Exercise 2.

1. p, t, ch, k, b, d, j, g.
2. b, j, t, p, g, ch, k, d.
3. g, j, d, k, p, t, b, d.

A good plan is to cover up the shorthand and try to give the shorthand strokes for the letters in the key, afterwards checking with Exercise 2.

Long Vowels.—There are six long vowels in Pitman's Shorthand, as follows—

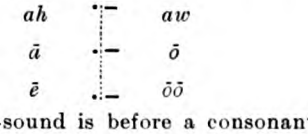
ah, ā, ē, aw, ō, ōō

as heard in

tah, Tay, tea, taw, tow, too.

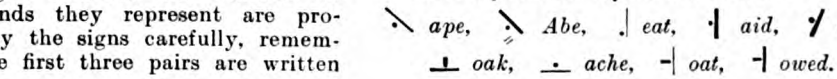
The first three are represented by a heavy dot, and the second three by a heavy dash. To accommodate these, each alphabetic sign has three places—a beginning, a middle, an end—and the places are named first-place, second-place, and third-place ; thus—

Ah and *aw* are written in the first-place ; *ā* and *ō* in the second-place ; *ē* and *ōō* in the third-place ; thus—



If the vowel-sound is before a consonant, the vowel-sign is written on the left-hand side of downstrokes and above horizontals ; if after, the vowel-sign is written on the right-hand side of downstrokes and below horizontals ; thus—

Vowel-signs read before the stroke—



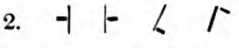
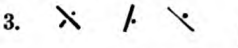
Vowel-signs read after the stroke—

pay, *bay*, *tea*, *day*, *jay*, *Co.*, *Kaye*, *toe*, *dough*, *gay*.

Capitals are indicated by a double line; thus, *Joe*.

Exercise 3

Read, write, and transcribe, giving the vowel and consonantal sign their correct sound-names.

1.
2. 
3. 

Key to Exercise 3

1. eight, Tay, owed, dough, pa, bah, tea. eat.
2. oat, toe, chew, jaw, caw, paw, key, oak.
3. obey, jay, pay, Joe, bow, Jew, coo, tah.

The Alphabet (*contd.*).—Further alphabetic strokes are given below—

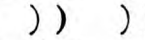
F		*ef*	as in *fee*.	S	*es* as in *gas*.
V		*vee*	,, *eve*.	Z	*zee* ,, *gaze*.
TH		*ith*	,, *bath*.	SH	*ish* ,, *lash*.
TH		*thee*	,, *bathe*.	ZH	*zhee* ,, *Liége*.

Note that all these strokes are written downward, and in pairs, and that the thick curves taper at each end. As in the case of the first eight, write the following exercise—

Exercise 4

F, V

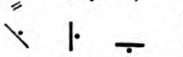
TH, TH

S, Z 

SH, ZH

Pay special attention to *z* and *zh*: the former is heard in *zoo, zeal, raise, lays;* the latter in *vision, régime, Vosges*. Using the long vowel-signs several more words can now be written, as in *foe*, *thaw*, *sow*, *shoe*.

Exercise 5

1.
2.
3. 

Key to Exercise 5

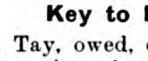
1. fee, fah, fay, faugh, foe, Shaw, show, shoe.
2. Esau, show, ease, Zoo, oath, ooze, shah, shay.
3. pay, day, gay, sow, chew, bay, oat, ace.

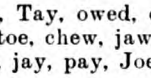
The Alphabet (*concld.*).—To complete the consonants of the alphabet, eight more strokes are provided as follows—

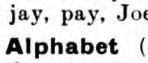
M		*em*	as in *lame*.
N		*en*	,, *lane*.
NG		*ing*	as in *ling*.
L	(up)	*el*	,, *ale*.
R	(down)	*ar*	,, *air*.
	(up)	*ray*	,, *ray*.
W	(up)	*way*	,, *way*.
Y	(up)	*yay*	,, *yea*.
H	(up)	*hay*	,, *hope*.
	(down)		*high*.

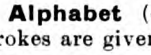
The first three are written from left to right in the same direction as *k* and *g*; *l* is written upward; there are two forms for *r* and two forms for *h*; all straight upstrokes slope at 30° from the horizontal.

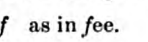
Exercise 6

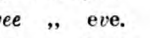
M 

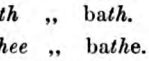
N 

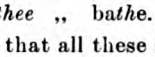
NG 

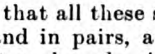
L (up) 

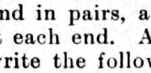
R (down) 

(up) 

W (up) 

Y (up) 

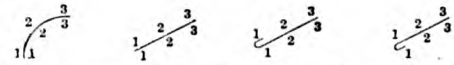
H (up) 

(down) 

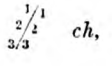
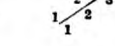
More words can now be written as follows—

aim, *May*, *knee*, *law*, *low*, *ore*, *row*, *ye*, *hay*, *hoe*.

Note that *l*, *r*, *w*, *y* being upstrokes, the vowel-places are reckoned from the beginning; thus—



In this connection it is well to contrast *ch* and *r*; thus—

 *ch*,  *r*.

Exercise 7

1.
2.
3.
4.

Exercise 8

1. paw, jaw, chew, Daw, gnaw, ape, aid, day.
2. pay, lay, ale, low, Lowe, thaw, oath, woe.
3. bay, tea, ache, gay, foe, eve, shoe, ma.

MAN'S NEAREST RELATIONS.

Reading from left to right, the animals shown are as follows.—Top row: The Capuchin Monkey, the Spider Monkey, and the White-handed Gibbon. Middle row: Orang-utans (male and female), and the Leonine Monkey (so called because of its likeness to the Lion). Bottom row: The Sacred Baboon, the Marmoset, and the Gorilla.

[*See* Zoology pp. 87—92, and pp. 153—157.]

Continued from page 6.

ENGLISH LANGUAGE AND LITERATURE:

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PRE-CHAUCERIAN LITERATURE

THE earliest English literature, considerable in amount, written by one author, and readable to-day for pleasure, came from the pen of Geoffrey Chaucer during the last thirty years of the fourteenth century.

With Chaucer the modern literature of our tongue begins. He is the first of our writers whose life and personality are so well known that they add a charm to his writings.

In his works of about five and a half centuries ago the English language took such a form, after many changes, that we can understand and enjoy it now without much special study. Writing that comes to us from beyond his time is either in a foreign tongue from our present-day point of view, very fragmentary, or in a large degree obsolete.

Eight hundred years before Chaucer the English had made the greater part of this country their own. Like all primitive peoples of the white races, they had a literature of songs and poetical stories preserved by memory, and perhaps even written in forms now lost. A hundred years after their settlement here they were to a large extent Christianised, and began to write religious poetry.

THE EXETER BOOK.

One of a number of MSS. presented to Exeter Cathedral by its first bishop, Leofric (*circ.* 1046); it contains a metrical "Life of St. Guthlac" and much religious verse.

But neither then nor for many centuries was their language English as we know it. Through all these centuries it was changing, both its grammatical form and its vocabulary, and while such fragments of writing as have been preserved from this period of change are part of the literature of the English race, they are not a part of the literature of the English tongue, for that has been almost wholly reformed, and is curiously composite and comparatively modern.

If we wish to study English from the point of view of the growth of language, before printing had a steadying effect, we shall find there was first an Anglo-Saxon period, when the language was German in its grammatical construction. Then, very gradually, came a transitional period.

Though the study of the breaking down of the old Teutonic forms of speech and the slow upbuilding of modern English is interesting in itself, and incidentally illustrates much history, it does not greatly concern us here. Our object is to trace only those finer examples of literature which remain so vivid, inspiring, or beautiful that they establish themselves as classics, and delight for ever the receptive reader; and, before Chaucer, but little writing in the language of Englishmen reached this standard.

The most vigorous poetry in the original English tongue comes to us from the very earliest days, when our pagan forefathers were crossing the North Sea to wrest the greater part of Britain from its Celtic owners. Several short poems, and one of over three thousand lines, have been preserved. The long poem, *Beowulf*, reaches us by means of a separate manuscript. The shorter poems are copied in a manuscript collection probably made about the time of King Alfred, and now called *The Exeter Book*, because for nearly eight and a half centuries it has been in the library of Exeter cathedral. These invaluable literary remains have been translated into English—*Beowulf* by the Victorian artist-poet William Morris, and the shorter poems, such as *Widsith*, *The Wanderer*, *The Plaint of Deor* and *The Ruined City*, in Stopford Brooke's fine critical study, *Early English Literature*.

Saxon Gleemen

The gleemen, or singing poets, of our Saxon ancestors kept heroic deeds in memory by chanting them in unrhymed alliterative verse around the fire of the chieftain's hall. Partly historical, largely mythical, *Beowulf* is the only lengthy narrative of its kind that exists in Anglo-Saxon. Its historical foundation is laid in Denmark in the middle of the sixth century. Originally a pagan story of strenuous heroism displayed under magical conditions, it has evidently been edited, during its written transmission to us, by a reviser who had some acquaintance with Christian thought.

Widsith tells of the travels of a gleeman sure to meet, in north or south, with someone who appreciates his song. *The Wanderer* describes the terrible loneliness, in those rough times, of a lordless man; that is, one who had no master or protector. *The Plaint of Deor* suggests a stoical endurance of misfortune; and *The Ruined City* pictures the savage overthrow of a Roman settlement. A much later poem, *The Battle of Brunanburh*, is linked in spirit with these stern fragments of song. It has been preserved by being copied into the *Saxon Chronicle*, which King Alfred started, and a translation by Tennyson has made it familiar.

These poems by men of the English race, circulated at first by voice, in a tongue that is no longer English, have more true poetic quality than any secular verse produced in our land during many succeeding centuries. Through them echo strains of manliness still found in our national character. They make courage the prime virtue. They glorify steadfast endurance. They place personal honour above life. They find romance in the zone of danger, revel in struggles against Nature in her grimmest moods, and show a love of the rougher aspects of outdoor life.

After the acceptance of Christianity, Anglo-Saxon poetry took the form of expansive paraphrases of the Scriptures, notable instances being Cædmon's description of the Creation and Cynewulf's *Christ*.

Whether any of the compositions of Cædmon have survived is very doubtful. His reputation as a poet depends on the judgment of the Venerable Bede that none could sing like him. Cædmon, Bede tells us, was a hind employed about the Abbey of Whitby. He dreamed poetry as he slept in the cowshed, and remembered it when he awoke. Afterwards the gift of song remained with him, and as a monk he devoted himself to religious verse.

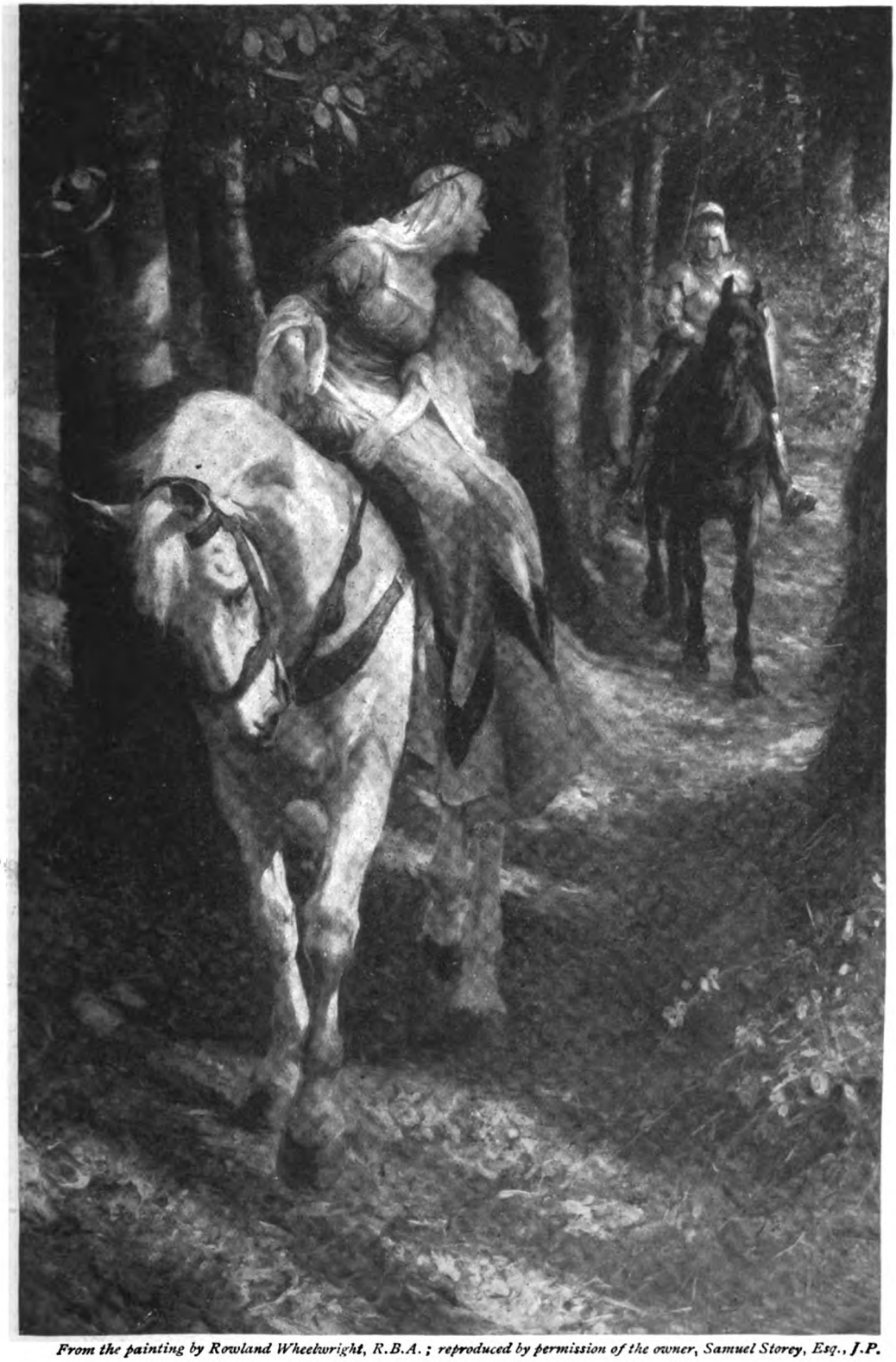
Cynewulf, probably like Cædmon a Northumbrian, was a scholar. His semi-scriptural poems, based on Latin originals, were exalted by a fine and intense note of personal piety. Since the days of Cædmon and Cynewulf, whenever England has become vocal in song, echoes of their religious faith have been heard in her poetry.

The Arthurian Legends

From before the Norman Conquest until the middle of the thirteenth century scarcely a strain of native poetry reaches our ears; but the materials for much romantic verse were being prepared. During this period France was the land of song. There, metrical stories were being shaped and amplified from the romances of all nations. Through Latin came suggestions for tales of Alexander the Great. Charlemagne was made the centre of another cycle of romance. Arthur, the legendary King of Britain, was a fruitful theme. Later, out of the struggle with the Moors in Spain, arose the epic of the Cid. Germany about the same time evolved its Niebelungen Lied.

All this brought, immediately, no lasting poetry to England, though the Arthurian group of legends came home stored with largesse after many years.

The origin and early travels of these legends are quaint. Towards the close of the first half of the twelfth century a priest, Geoffrey of Monmouth, who, later, became Bishop of St. Asaph, wrote in Latin a wildly fanciful *History of the Kings of Britain*. It was based to a slight extent on Latin records, such as Bede's, but chiefly on Welsh legends,



From the painting by Rowland Wheelwright, R.B.A.; reproduced by permission of the owner, Samuel Storey, Esq., J.P.

ENID AND GERAINT.

Geraint, a knight of the Round Table, became suspicious of his wife's fidelity. But the loving care with which she nursed him, when wounded, convinced him of his error; "nor did he doubt her more, but rested in her fealty, till he crowned a happy life with a fair death."

The Parson.

The Franklin.

The Squire.

supplemented by bold invention. Arthur was made the great hero of the land.

This history was translated into French by Wace, who added his quota to its wonders. He it was who introduced the Round Table. The French romanticists for generations diligently developed and added to the stories. Seventy years after Geoffrey's book had gone to France, Layamon, an English priest of a zealously patriotic spirit, living on the banks of the Severn, conceived the idea of telling the tale of Britain, and particularly of Arthur, in the English vernacular, using the alliterative form of verse which the common people still appreciated. So he translated Wace's *Brut* from the French, and expanded and embellished it with new legends gathered from the Welsh borders.

Brut, or Brutus, was supposed to be the original founder of Britain, hailing from Troy. Thus, through Layamon, British romance came back into English verse, though in a form too archaic for the modern reader. Now we can only think of Arthurian legends as they appear in Malory's fascinating prose translation, or in Tennyson's graceful narratives; but Layamon was not devoid of poetic insight, as may be judged from a prose rendering of the passing of Arthur:

> Then from the sea, borne on the waves, came a short boat, and two women therein wondrously arrayed; and they took Arthur anon and bare him quickly, and softly laid him down, and fared forth away. Then was brought to pass that which Merlin whilom said, that there should be sorrow untold at Arthur's forth-faring. The Britons yet believe that he is alive, and dwelleth in Avalon, with the fairest of all elves, and ever yet the Britons look for Arthur's coming. Was never the man born, nor ever of woman chosen, that knoweth the sooth to say more of Arthur.

Layamon's *Brut* marks the time when Anglo-Saxon was so far losing its German inflexions as to be partly readable by us to-day. Between its publication and the time of Chaucer we must not look for poetry to any writer whose name is known, but into the memory of the populace, which preserved certain songs and ballads that had been produced no one can say when or how.

NOTE REGARDING THE ILLUSTRATIONS.—The figures shown on this and the page opposite are reproduced from the Ellesmere MS., one of the best of the known MSS. of *The Tales*.

The Nun's Priest.

The Clerk.

The Doctor.

Chaucer.

The Friar.

The Sailor.

The earliest poetry had been made for the chieftain's hall. Later, in the religious houses, poetry became the handmaid of religion. Still later it was an amusement for castle and court in the days of chivalry. But remnants which have reached us show that all the while there was a poetry of the people accompanying the merriment of rural life in happy times.

Through song man gave a voice to the new life of earth in the spring. He loved to tell and hear simple tales of love and hope and doom, often with a refrain for singing like the rhymes of children's games. And there were the popular stories of liberty and adventure, such as the ballad cycle of Robin Hood. Some of the elaborated forms in which we have these ballads now were shaped at a later date, but the original rhymes had been framed as early as the thirteenth century, for, as we learn from *Piers the Plowman*, they were universally known by the middle of the fourteenth century.

That there were strains of pure poetry during this period may be seen in such songs as the well-known "Sumer is i-cumen in," the first lyric transmitted to us with its music; and in such carols as that descriptive of the coming of Christ:

He came all so stylle there his moder was,
As dew in Aprille that falleth on the gras;
He came all so stylle to his moder's bower,
As dew in Aprille that falleth on the flower;
He cam all so stylle there his moder lay,
As dew in Aprille that falleth on the spray.

In such lines as those spoken by Eve in the ancient Coventry play:

Alas that ever that speech was spoken
That the false angel said unto me,
Alas our Maker's bidding is broken,
For I have touchéd his own dear tree.
Our fleshly eyen been all unlokyn [unlocked],
Naked for sin ourself we see,
That sorry apple that we hav sokyn
To death hath brought my spouse and me.

Or in the opening lines of the fine ballad of *Robin Hood and the Monk:*

In somer when shawes be sheyne,
And leves be large and long,
It is full merry in fair forést
To hear the fowlés song;

The Second Nun.

The Cook.

The Knight.

To see the deer draw to the dale,
And leave the hillés hee,
And shadow he i' the levés green
Under the greenwood tree.

Already rhyme was fully accepted from the French, and though the German ending in *e* remained, as in fowlés (birds), hillés (hills), and levés (leaves), the French accent on the last syllable, as in forést (usages presently to be noticed in Chaucer), had been adopted in popular song. The old alliterative verse, with its stresses on two or three similar first letters in each line, was overpast, and what Freeman calls "the jingle of endings" had superseded "the jingle of beginnings."

The time was ripe for a commanding poet, who should so use in musical measures the old English tongue, shorn of its cumbrous inflexions and modified by the graces of French, as to establish once for all a language rich, flexible, and capable of accepting additions from any source of expression, old or new. This was the work that fell to Chaucer, and was by him unconsciously accomplished.

The undetermined state of the language, from a literary point of view, is illustrated by the writings of John Gower, Chaucer's contemporary and friend. Gower wrote three considerable poetical works: one in Latin, which remained the language of the Church and the scholar; one in French, which was still the language of "society"; and one in English, which, under the national concentration that accompanied the wars of the Edwards, aided by the literary adoption of the East Midland dialect as the standard tongue, was becoming the language of a united people, and known to all classes.

"Piers the Plowman"

The last considerable poem written in the old English, in the old form of verse, was *The Vision of William concerning Piers the Plowman;* and before considering the new work of Chaucer, we may glance usefully at this literary farewell, partly because it illustrates the conditions under which all books were made before the use of printing.

That the *Vision* had a wide popularity is proved by the number of manuscripts in existence now. A comparison can be made of forty-five ancient copies of the poem. They reproduce it in three forms, or stages. Until recently, a carefully elaborated account of the author and the three versions of his poem was generally accepted.

William Langland, a Churchman in minor orders, born of poor parents in Shropshire, is supposed to have lived first at Malvern and then to have moved to London, where he earned a precarious livelihood as a copyist and by saying masses for the dead. Tall, gaunt, unapproachable, poor, embittered, he was stirred to the depths of his nature by corruption in the Church and the miseries and demoralisation of the people, who were suffering under the ravages of the "Black Death" plague.

In the guise of a vision that came to him as he lay on the Malvern hills he saw an assemblage of all the grades of the society of his day, and, after satirising their wrongdoings and futile quests, he showed that only by love in the spiritual region and by hard work in practical life could personal and social regeneration be attained. These lessons were taught through the introduction, in action and dialogue, of symbolical characters, such as Truth, Falsity, Reason, Conscience, Sloth, Gluttony, etc. Piers the Plowman, the ultimate arbiter, is Christ.

Did Langland Exist?

This allegory, satire, and appeal was first written about 1362, in twelve cantos, containing three visions. Fifteen years later the author is supposed to have revised the poem and nearly trebled its length. Again, twelve years later, it has been inferred, he revised this revision. All these versions are extant, and were published for comparison by Dr. Sweet, the expert in Anglo-Saxon. It is generally admitted that the tinkering of the poem, particularly in the second revision, was no improvement. What is supposed to be known about the author is gathered from personal references in the poem itself, and from entries, which may have been surmise, made on manuscripts by transcribers long after the poet's death.

Recently, questions have been raised respecting each statement in this once accepted life-sketch. Was there a Langland at all, or was the "Long Will" of the poem only a convenient dream-figure used to launch the story? Did the original author write all the twelve cantos, and revise them twice at long intervals in later years?

The conclusions arrived at by Professor Manly, of Chicago University, from the different wordings of the poem in different versions, and the changes in style and point of view as the work proceeds, are that the original writer, a man of constructive and to some extent dramatic genius, wrote the first eight cantos as a first draft, and that the remaining four cantos were added by another hand, the conclusion of the twelfth canto being by a third author. The first

expanding revision was made by a social reformer with great enthusiasm, and some poetical feeling, but a singular lack of mental grip; while the last revision was made by an editor of greatly inferior power, with a point of view different from that of the original author.

The alliterative style and democratic spirit of the first reviser and expander of the poem may be seen in such lines as:

> For all are we Christ's creatures, and of his coffres rich,
> And brethren of one blood, as well beggars as earls.

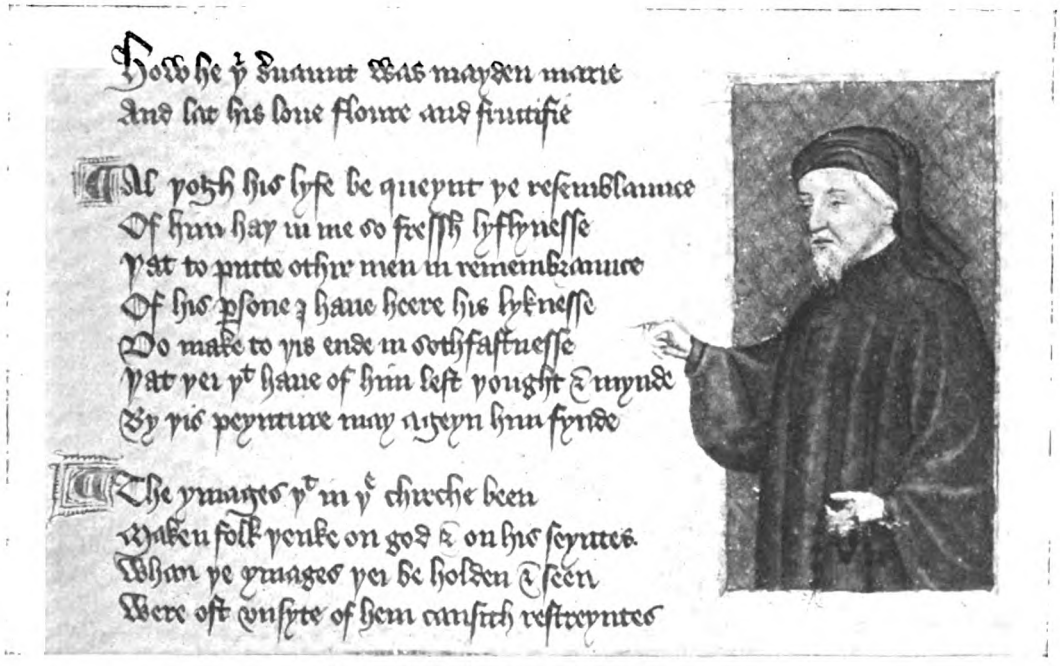
When we turn to Chaucer from the earlier poets we feel there has been a transformation, both in language and in the skill and spirit with which it is used. It has been said that Chaucer "found English a dialect and left it a language," and there is a large measure of truth in that exaggeration. Certainly he helped to weld into one the Anglo-Saxon and French elements in common use; and in doing that he wrote as no one had ever written before, for he wrote English as a literary artist.

When he died, and was buried in what is now called "The Poets' Corner" of Westminster Abbey, England had, in his writings, the nucleus of a literature which already displayed some qualities that have not been surpassed. Manliness of tone, breadth of human interest, the incessant glint of humour, delight in the play of character, felicity in description, with ease and smoothness in story-telling, may not be the greatest features of literary style, but they had not been combined before Chaucer in any English writer, and, since, they have not been seen in as happy a combination except in Shakespeare.

Chaucer did a great national work in standardising our language, because his skill and his broad, temperate, worldly character were just what the country needed at the moment. He did not do this work by consciously trying to do it; but he did it incidentally, in the course of a busy life. It was the natural outcome of a career of extraordinary range, touching the social life of the day at many points, and of a mind that was instinctively liberal, whether lost in contemplation or fascinated by the by-play of human character.

By tracing Chaucer's life, we shall see how his experience made his literary work possible, though it increases our wonder at his industry in dissimilar pursuits.

J. D.



OCCLEVE'S PORTRAIT OF CHAUCER,

Which according to Skete (*Chaucer's Works*, vol. 1, p. 59) is "probably the only one which can be accepted as authentic."

THE ENGLISH LANGUAGE.—I

A NATIONAL language like ours shares in the changes and vicissitudes of the people who speak it. Like the nation itself, it is a living thing, changing and evolving from generation to generation in response to new conditions and modified environment. That this is true of English will be evident from the experience of everyone. If, for example, one were asked to-day, "What is a *tank?*" his answer would be different from that which would have been given a short time since. And, again, an Englishman of a generation ago could have given no meaning to such familiar words as *garage*, *hangar*, and many others. Still further, everyone is aware that in America, even in Canada, the English language has developed its peculiarities, not merely in the meanings, but also in the usages and spelling of words. Languages, in short, and the individual words of which they are composed, have their history, just as nations have, and the men composing them. This history shows them to be related to, and to have interacted with, other languages—a process, like the interchange of culture between nations, which is beneficial to all concerned. The study of the development and inter-relation of languages constitutes the science of **Philology**; and a fascinating science it is.

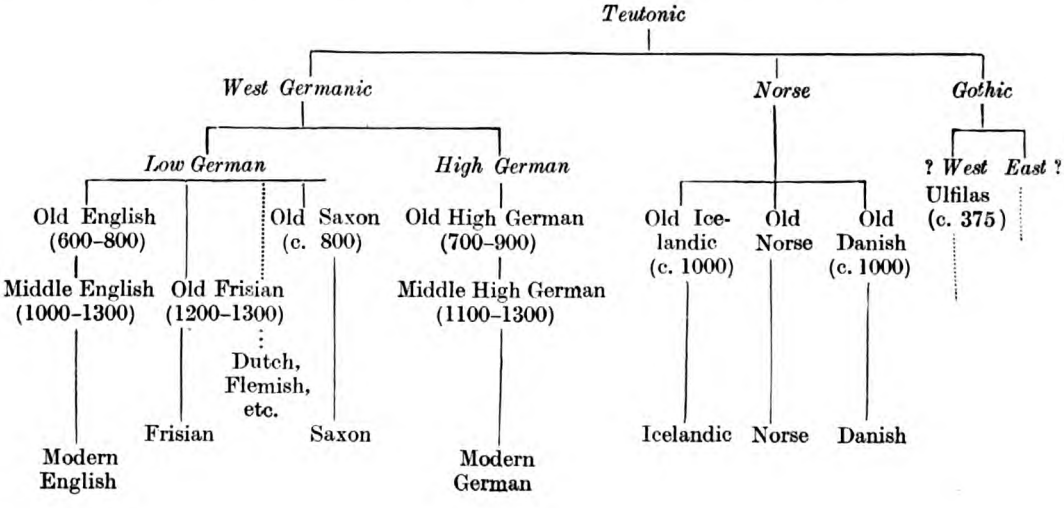
The Teutonic Family of Languages

The story of the English language, like the history of the English people, can be traced backward with reasonable certainty in regard to its general development, but with some obscurity in matters of detail, to the sixth century, when the Angles and Saxons made their conquest of the country. Farther back than this we are lost in the mists; knowledge has the merest fragment of a foothold in those dim hinterlands: hints, comparisons, inductions, suggestions, we have; and out of them a consistent and likely theory of the early philology of our English tongue has been built up.

Old English

A study of the Old English revealed in *Beowulf*, in the poems of Cynewulf, or in the prose-writings of King Alfred, brings to light the fact that in its early stages English was much more like German than it is now. This is clear, no less in the vocabulary of the language than in its grammatical peculiarities and usages. Moreover, the relationship between Old English and German is far closer in every respect than any which existed between English and French or Spanish or Italian at the corresponding period. For these reasons philologists have, in their classification of European languages, placed English and German together in the Teutonic Family of Languages, to which belong also the Dutch and Frisian, Icelandic and Norse tongues, as well as the Old Saxon of the poem called *Heliand* (c. 800) and the Mœso-Gothic fragments of a translation of the Bible made by Ulfilas about the year 375 A.D. This latter is the oldest specimen of Teutonic language extant; it is a verbal translation of the Greek text, and preserves the primitive vocabulary of the Goths.

The connection between these various languages or dialects is tentatively illustrated in the following pedigree; in this, those dialects of which no positive remains exist are indicated by italics :—



We may thus picture our remote ancestors, in the centuries before the great Teutonic migrations, using a rude primitive language with a scanty vocabulary and a cumbrous grammar containing some of the peculiar features that still survive in German; this primitive language was modified, as the peoples found new and different scenes and customs, into at least three forms—the West Germanic, Norse, and Gothic—of which no written memorials remain. The first of these forms, used by the people along the valleys of the Rhine and Elbe, followed two main lines of evolution, the Low German and High German, which survive in their most highly developed forms in Modern English and Modern German respectively.

Deeper and more detailed research has shown that the Teutonic family of languages is not an isolated group, but descends from the much wider Indo-European or Aryan family, which includes the Celtic, Latin, Greek, Indo-Iranian and Slavonic families, so that a kinship is established among all the languages of Europe and nearer Asia, which excludes only a few dialects like those of the Magyars and the Basques, and the Semitic languages of the Turkish Empire.

Early English

The English language has, much more than the German, been responsive to external influences, and in consequence of this it has been far more profoundly changed. The most important of these influences, from the point of view of the language, was the introduction of a French type of civilisation into England during the Norman and Plantagenet periods of our history. In those centuries, say from 1050 to 1350, the monarchs were to all intents and purposes Frenchmen; French was the language of the Court and of Society; even as late as Chaucer's time France was the "glass of fashion" and the arbiter of taste in England. In spite of this the English language survived as the national speech, and a monarch like Edward I. came to regard the English element of his kingdom as the fundamental one. The wars of Edward III. clinched this sense of national consciousness, and at the same time assured the final victory of the English tongue in the work of Geoffrey Chaucer.

In winning the victory, however, the language obtained many wounds, some of which were vital to its former character. French words were introduced, many of them to the ultimate extinction of their Old English equivalents; and these words did not fall easily into the complex scheme of Old English grammar. The result was a gradual simplification of the whole structure and design of our language which gave it a new freedom and grace, a pliant and flexible adaptability, which brought it very near to the level of the more developed French and Italian as a vehicle of expression. The diction of Chaucer is not tawdry, even in comparison with Dante, and is far superior to that of his best French contemporaries.

Inflections

Let us look briefly at the nature of the grammatical changes that had slowly come over our language.

(1) Old English was a completely inflected language. An inflection is a suffix added to the root of a word to indicate some modification of its meaning or of its relation to other words. A few inflections survive in modern English, which will sufficiently explain what is meant. Thus the suffix **-s** indicates the plural number of a noun, as in *boys*. Its use is obvious; it is a convenient device for speaking of more than one boy. Again, the suffix **'s** conveniently denotes what is called the possessive case, as in *the boy's book*. Now, in this latter example, consider what would be done if we had no inflection for the possessive. We should be compelled to use a phrase or even a sentence in order to express the same sense. Thus we might say *the book of the boy*, or *the book belonging to the boy*, or *the book which belongs to the boy*, etc. The inflection gives us a much more concise way of expressing our meaning, and we might on first thoughts suppose that a highly inflected language is the desirable type to aim at. It certainly has the advantage of logical exactitude, as learners of Latin will realise. But in practical use we find it more convenient to reduce inflections to the minimum.

Old and New

The English language has dispensed with inflections: (*a*) by abandoning those which are useless; or (*b*) by the use of prepositions or other words which indicate relation.

As an example of (*a*), we set side by side the forms for the present tense of the verb *to bind* in Old and Modern English:—

	O.E.	*M.E.*
Infinitive . .	bind-**an**	to bind
Singular **1** .	bind-**e**	bind
„ **2** .	bind-**est**	bind**est**
„ **3** .	bind-**eth**	binds
Plural **1, 2, 3** .	bind-**ath**	bind

Thus there were five different forms in O.E., and three in Modern English: of the

original five, one only remains, and that is obsolete in the spoken language of the people; the inflection of the third person singular has been totally changed by steps which we need not pursue: it survives as a convenient device for distinguishing the singular from the plural number.

As an example of (*b*), we compare the forms employed in nouns :—

Case.	*O.E.*		*M.E.*	
Singular :—				
Nominative	scip	lufu	ship	love
Objective	scip	lufe	ship	love
Genitive	scipes	lufe	ship's	love's
Dative	scipe	lufe	[to (the) ship]	[to love]
Instrumental	scipe	lufe	[by (the) ship]	[by love]
Plural :—				
Nom., Obj.	scipas	lufa	ships	loves
Genitive	scipa	lufena	ships'	loves'
Dat., Instr.	scipum	lufum	[to or by ships]	[to or by loves]

From these examples we notice several points. First, that O.E. was not a perfectly inflected language, inasmuch as the same inflection was used for different purposes. Secondly, we have abandoned, as O.E. had to some extent, the separate inflection to indicate the object. Thirdly, the dative case, or case of the indirect object, had in O.E. its own separate inflections, which have been entirely lost in Mod.E. Indeed the case itself need not be recognised in Modern English grammar. It survives in a few pronouns (give *him* a book, e.g.), but in nouns we may regard an apparent dative as an objective, governed by an understood preposition *to* (e.g. give *the man* a book = give a book *to the man*).

Questions of Gender

Finally, we notice that in O.E. there is more than one method of inflection, which, of course, adds to the difficulty of Old English grammar. This is associated with the fact that distinctions of gender in O.E., as in German, Latin, French, etc., were not necessarily distinctions between male and female.

In O.E., as in other languages, adjectives were made to agree with the nouns they qualified, and this involved the full declension of adjectives in three genders. Further, O.E. shares with German the peculiarity of having two different sets of forms, the strong and the weak, corresponding to the different uses of the adjective, whether as a predicate or as an attribute: e.g. the man is *good* (predicate: strong adjective); the *good* man (attribute) = O.E. se *gōda* man (weak adjective). All these distinctions have vanished from Modern English, and one form suffices for the adjective under all circumstances. The French still write *les bons* garçons, but we do not wish to imitate them with *goods* boys. The inflected adjective is a nuisance in speech, even if it satisfies our logical sense in writing. None of the elaborate inflections of the article *the* survive as such; but *these* and *those*, as the plurals of *this* and *that*, still remind us of the old habit.

The inflections **-er** and **-est** for comparison are, of course, still used, but they are not often added to new words of French or Latin origin: we prefer *fairer* to *more fair* generally; but we do not like *beautifuler!*

In pronouns a number of inflected forms remain, e.g. *mine*, *our*, *you*, *his*, *her*, *their*, *whose*, *whom*, etc., but by no means all that were once employed. The **-m** in *him*, *them*, *whom* is an interesting survival of a dative termination now used as an objective.

Strong Verbs

One of the characteristic features of the Teutonic group of languages has lasted, essentially unchanged, both in English and in German. Amid a great deal of inflectional loss, we retain in our verbs the old methods of tense-formation. Both the *strong* method, by change of the root-vowel (e.g. *sing*, *sang*), and the weak method, by addition of **-d** or **-t** (love, loved), have prevailed from the Old English days till now. But of these, only the weak method is *alive*, in the sense that it is applied to new verbs. The processes which led to the vowel change were completed long before the written period of our language began, and the conditions for their operation do not exist now. Consequently we do not form new strong verbs, although the old ones are permanent parts of our language.

As examples for comparison we give the verbs *find* and *love*, in O.E., Mod.E., and Modern German :—

	Verb.	*Past Tense.*	*Past Participle.*
O.E.	findan	fand	gefunden
Mod.E.	find	found	found
Mod.Ger.	finden	fand	gefunden
O.E.	lufian	lufode	gelufod
Mod.E.	love	loved	loved
Mod.Ger.	lieben	liebte	geliebt

It will be noticed that the past participle retains in German not only the old suffix, but also the characteristic prefix, which in English gradually softened into **y-** and finally vanished.

E. W. E.

Continued from page 14

HISTORY:

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ANCIENT ROME

THE city-state was not an institution peculiar to Greece. Italy also had her city-states, though they never attained to the degree of development reached by the city-states of Greece. The country, indeed, did not lend itself geographically to the formation of such states.

Italy, although cut in two by the Apennines—a chain of mountains extending from one end of the peninsula to the other—is not, like Greece, naturally divided into a number of isolated territories; nor has it a coastline broken up into a number of rugged small peninsulas. Comparatively speaking, Italy is an open country, and on this account the early settlements, or states, failed to acquire that individuality and sense of independence which characterised the states of Greece, and which grew stronger, rather than weaker, under the influence of civilisation.

In Italy, moreover, there soon arose a state which had both the inclination and the ability to dominate the rest.

Rome's Civilising Sword

Now in this state, Rome—the city destined to become not merely the mistress of Italy, but the seat of government of the two greatest empires (the one spiritual, the other temporal) that the world has ever seen—the sense of rule was instinct from earliest times; and in the rise of Rome is wrapped up entirely all the history of ancient Italy.

Greece was an influence upon the development of the human race—a gentle, uplifting influence. Rome was the driving force.

Throughout the course of her history, Rome displayed no original artistic or literary ability. The culture which she adopted, and which she spread to every corner of her vast Empire, was Greek culture. The sword carried that culture, but law enabled it to take root. And upon those two foundations—Greek culture and Roman law—rests the whole fabric of modern civilisation.

Rome is generally believed to have been founded towards the middle of the eighth century before Christ, but regarding the early history of the state we know very little. This much may be said with certainty—Rome, like Athens and the other states of Greece, was governed originally by kings, responsible in some measure for their actions to a Senate, or council of elders, and the Assembly of the people.

Now, the power of the Greek kings, as we saw on p. 10, slowly decayed. The kings of Rome, on the other hand, appear grossly to have exceeded their prerogatives, and to have earned the hatred of all classes of the community. At any rate, about the year 500 B.C. a revolution occurred, the monarch was expelled, and thenceforth no king reigned in Rome till 1871, when the city became the capital of a united Italy.

A Democracy in Theory

After the expulsion of the kings, the Roman State became a Republic, the authority formerly held by the kings being vested in two magistrates, or consuls, who were elected each for one year.

At first only men of patrician or noble rank were eligible for office. But this proved a source of great dissatisfaction to the *plebs*, or people, who soon found themselves being ground under the heel of a ruling class more remorselessly even than in the days of the monarchy. At last, therefore, having failed by other means to secure redress of their many grievances, the whole body of the *plebs* went "on strike," and for a while the safety of the state was gravely menaced, a war being in progress at the time; and it was from the *plebs*, of course, that the fighting forces were almost exclusively drawn.

In the circumstances, the patricians had no alternative other than to make terms; and they agreed to allow the *plebs* to elect annually from their order two tribunes, who should have sufficient power at any rate to safeguard the liberties of those whom they represented. From this time onward

the privileges of the people were gradually extended; and a very important concession was made in the year 367 B.C., when it was enacted that in future one of the two consuls must always be of plebeian rank.

Rome thus became, in theory at any rate, a democratic state; but it is very doubtful if the change conferred any material advantage on the people, for, even as things were, only men of considerable means—were they patricians or plebeians—could possibly afford to occupy any of the high offices. The change tended, therefore, merely to substitute for an aristocracy of birth an aristocracy of wealth—a greater evil for a less.

Political Boundaries

It must not be thought that during the development of the great constitutional struggle, roughly outlined above, Rome remained wholly absorbed in her internal affairs. The Romans, like the British of modern times, despite party strife, always proved able to present a solid front to enemies; and even at times when the State was convulsed by faction wars, the proud city on the seven hills continued steadily to expand the boundaries of her dominions.

Early Italy was inhabited by many different tribes and races.

In the north, in the country between the Tiber and the Arno, lived the Etruscans, a people who had settled there long before the beginning of authentic history, and concerning whose origin very little, if anything, is known.

South of the Tiber, the rich country on the west between the Apennines and the sea was occupied by Latins. The Latins were an Aryan people, and at the time of the migrations probably formed a part of that same swarm which overran Greece. So also, it would seem, did the Oscans, who settled mainly on the Adriatic coast of Italy.

A League of Tribes

Along the rugged south coast, and on the island of Sicily, the Greeks at a very early date planted many colonies; whilst the extreme north of the peninsula was inhabited on the west by the Ligurians and on the east by Gauls.

Rome was able, on account of her situation, to serve as a frontier fortress between the Latins and Etruria; and, largely because of this, she soon acquired a marked ascendancy over all the Latin people. Neighbouring communities she incorporated with herself; the more distant ones she formed into a League, pledged to support her policy; then, aided by the Latins, undertook the subjugation of Southern Etruria.

Early in the fourth century, Veii, the foremost of the Etruscan cities, was taken after a memorable siege, and Rome seemed well on the way to conquer the whole country, when suddenly a great disaster overtook her.

The Gauls from the north, pouring over the Apennines, swept down upon the plains of Etruria, and quickly cleared the district of Romans. Advancing boldly, these new enemies then laid siege to, took and sacked the city of Rome itself, though, according to the well-known legend, the fortress on the Capitol remained intact—saved by the sacred geese, whose cries warned the garrison of the imminence of a night attack.

Rome recovered from this stunning calamity with astonishing rapidity; and, having freed herself, after a long, desperate struggle, from Gaulish aggression, again set about the conquest of Italy. By the beginning of the third century she had accomplished the task, and made herself, to all intents and purposes, mistress of the peninsula, with the exception of some of the Greek colonies in the South.

The Ambitions of Pyrrhus

The newly acquired territories were planted out as colonies. These colonies originally were of two descriptions. Some were made Roman colonies proper, and merged entirely in the Roman state; others became what are called Latin colonies. The Latin franchise did not immediately afford the full rights of Roman citizenship. These colonies, therefore, though bound to accept and follow the policy of Rome in all matters of peace and war, had no voice in the directing of that policy; on the other hand, however, they were allowed a certain latitude in the management of their own internal affairs.

Rome was next drawn into a quarrel with Tarentum, the most prosperous of the Greek colonies in the south of Italy, and, as a result of the quarrel, became involved for the first time in a struggle with a really foreign enemy.

On the death of Alexander the Great, of whom mention was made on p. 11, the Macedonian Empire fell to pieces, and though it came gradually to be parcelled out among the conqueror's generals, a period of great confusion followed in the Balkans.

During this time, Epirus, a country hitherto of no importance, emerged suddenly from obscurity, and under King Pyrrhus became

a really powerful state. Pyrrhus was nothing if not ambitious. When, therefore, in 281 B.C. the Tarentines appealed to him for help against Rome, he eagerly responded, and crossed immediately over to Italy at the head of a large army.

At first the Roman troops were powerless against the Macedonian phalanx, and suffered defeat time after time. From his successes in the field, however, Pyrrhus could reap no advantage, for, although he vanquished Roman armies, Rome stood firm, and declined to treat with him while his troops remained on Italian soil. In the year 275 B.C., having exhausted his resources, the invader was forced to quit Italy, just as he had been forced to quit Macedon.

As a result of the war with Pyrrhus, Rome greatly strengthened her hold on the Greek settlements in Southern Italy, acquiring among other possessions the port of Brundusium (Brindisi) in Calabria. She thus found herself in a position seriously to turn her attention to the establishment of dominions over the seas; and it was with Carthage, the great Phœnician power on the northern coast of Africa, that she fought the first of her wars of aggression outside Italy.

THE FORUM ROMANUM—AS IT IS.

The Forum, the political centre of ancient Rome from the days of the Kings, was originally a market place. The temples and public buildings subsequently erected on the site were destroyed during the period which followed the fall of the Western Empire; and Time dealt very hardly with the ruins, for scientific excavation and investigation was not begun until 1870. The two drawings above show the Forum as seen from the Court of the Vestals' House. Among the buildings to be

From a reconstruction by J. Hoffbauer.

THE FORUM ROMANUM—AS IT WAS.

seen in the reconstruction are (on the left of the Via Sacra) the little circular Temple of Vesta, where burned the Sacred Fire, and the Temple of Castor and Pollux. In the distance (on the left) is the Temple of Jupiter Capitolinus. The large building on the right of the Via Sacra is the Temple of Julius Cæsar built by Augustus on the spot where the deified ruler was cremated. The equestrian figure on the right is a statue of Constantine II.

Carthage, in addition to bearing rule over Corsica and Sardinia, had at this time large possessions in Sicily; and it was the state of affairs in this latter island which provided Rome with a *casus belli*.

For a long time past Greek and Phœnician influence had been almost equal in Sicily, the Greeks holding the eastern portion, the Carthaginians the west. But, in consequence of the failure of King Pyrrhus's adventure, Greek power had materially declined in Western Europe, and so helpless and disordered had the Sicilian colonies become that the Carthaginians resolved to avail themselves of what seemed an easy opportunity to bring the whole island within their dominion.

Carthage, once established in Eastern Sicily, would immediately become a serious menace. Rome, therefore, was obliged to fight; and the struggle for supremacy in the Mediterranean raged with intermissions for sixty-one years, from 263–202 B.C.

The first Punic War, which lasted from 263–241 B.C., was fought mainly at sea, and resulted in Carthage being forced to relinquish her hold not only on Sicily, but also on Sardinia and Corsica; and she had to pay to Rome an enormous indemnity.

Twenty years of armed truce followed. Neither party regarded the peace of 241 as final; and while Rome set to work to secure the attachment of the conquered islands, Carthage, under the guidance of Hamilcar, sought busily to establish her power in Spain, so that she might still be able to dispute with Rome for the command of the seas to the west of Italy.

Hannibal in Italy

In 221 B.C. Hamilcar died, but the work of preparing vengeance on Rome did not then cease, for Hamilcar's mantle fell on a greater man—Hannibal, his son, one of the greatest soldiers the world has ever seen.

Now, Hannibal conceived the bold idea of invading Italy by land. Setting out from Spain in the summer of 219 B.C. at the head of 59,000 men—of whom only 26,000 survived the awful rigours of the march—he crossed the Alps, probably by the lesser St. Bernard, and succeeded in sweeping down into the plains of Italy before his enemies had time fully to realise the great danger which threatened them.

Armies were hastily raised, and sent north to meet the invader—armies which in some cases were four times as large as his own; but Hannibal destroyed them one after another. And for three years his soldiery overran the whole country, plundering and pillaging. Yet the fortresses of Italy, headed by Rome, still stood firm and determined; and Hannibal, having neither the men nor material to conduct long sieges successfully, began slowly to learn the same lesson that had been taught to Pyrrhus before him.

The Romans, moreover, acquired wisdom from experience, and, under the leadership of the Dictator Fabius, surnamed Cunctator (i.e. "the Delayer"), abstained from sending their armies to certain defeat, and, instead of giving battle to Hannibal, hung on his heels, harrying and hindering him.

Delenda est Carthago

Meanwhile, in Spain a Roman army, under Publius Scipio, was endeavouring to hold up the reinforcements that Hasdrubal, another Carthaginian general, had arranged to send to his brother, Hannibal. In the year 209 B.C., however, Hasdrubal succeeded in evading Scipio, and the next year, having made his way across Gaul and over the Alps, began to descend into Italy at the head of some 50,000 men. Happily for the destinies of Rome, the armies of Hasdrubal and Hannibal were never able to effect a junction, the former being defeated and utterly destroyed at the great battle of Metaurus (208 B.C.).

This defeat marked the beginning of the end of Carthaginian greatness. In the following year Scipio crossed over to Africa, where his brilliant generalship met with such success that the government had finally to recall Hannibal from Italy to defend the capital. Hannibal went; but although his own genius for war was still unimpaired, the long struggle had exhausted the military resources of his country, and Scipio gained a decisive and easy victory at the battle of Zama, 202 B.C.

It was not until some time later—in fact, not until 146 B.C., when the city of Carthage was razed to the ground—that Rome formally annexed all of her old enemy's extensive territories; but from the date of the battle of Zama, Carthage ceased to exist as a power in Western Europe.

Nor, during the years which marked the final reduction of Phœnician greatness, had Rome been idle in other directions. She had been anxious for a long time to take her revenge for the insults which Pyrrhus had heaped upon her, and in 229 B.C. began seriously to interfere in Greek affairs.

J. A. B.

(To be continued.)

Continued from p. 32.

SCIENCES:

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CHEMISTRY.—II

It is a matter of everyday experience that iron becomes rusty when it is exposed to a damp atmosphere. There are three common commercial forms of this metal—cast iron, wrought iron, and steel—all of which rust when exposed, their surfaces becoming covered with a soft, yellowish-brown-red powder. We, the scientific detectives, are asked to investigate this crime committed against the metal, whereby its bright metallic appearance has been disfigured and clouded over with a dull, sanguinary-looking scale.

Who or what are the agents that have perpetrated this crime? And how are we to guard against attacks in future? We must by means of the balance ascertain if anything enters or leaves the metal when it rusts.

Experiment I.—*To find out if iron gains or loses in weight when it rusts.*

We put some clean iron filings, or pieces of iron wire, on a watch-glass, and weigh the whole. After moistening with a few drops of water, we put the watch-glass aside for a day or more, and then, when the rust has appeared, we dry the rusted material in an oven and weigh again. If our work has been accurate, we find that a decided gain in weight has taken place.

(2) Weight of watch-glass and iron after rusting	7·248 gm.
(1) Weight of watch-glass and iron before rusting	6·910 gm.
Gain	0·338 gm.

Since the watch-glass cannot have changed—(how could this be demonstrated?)—the iron must have taken up something from somewhere. This experiment does not tell us what entered the iron, but it is legitimate to hazard a guess. The metal was only exposed to air and water, therefore either one or both of these materials, or parts of them, must have combined with the iron.

Experiment II.—*To find out if air combines with iron when it rusts.*

We shall confine some clean metal in a vessel containing air and standing over water in an open dish. If any part of the air unites with the iron, the pressure inside the vessel will be diminished and the atmospheric pressure outside will cause water to enter. A gas-jar is wetted on the inside, and some iron filings are made to cling to the moist glass by swirling them round in the jar. The latter is then placed in an inverted position in a trough or dish containing water (Fig. 1).

After the lapse of a day, or less, the water will be found to have penetrated into the gas-jar, but not very far. Therefore the rusting iron has taken up some of the air, but since there is plenty of iron left unrusted, it appears that only a small portion of the air actually combines with the metal.

We will put the jar back again into the trough in the same position as before, and see if the water will rise any farther. No, even after several days the water level remains stationary at the original point. This level should be marked.

To find out if the air left over is the same as the original air, we place a round glass plate, or disc, under the end of the jar under water, remove the jar, set it upright, and then plunge in a lighted taper.

The light goes out. We conclude that the original, i.e. ordinary, air consists of at least two parts: (1) a large portion which does not allow substances to burn in it (does not "support combustion"), and (2) a much smaller portion which entered the iron, and the presence of which in air enables substances to burn. The former is called *Nitrogen*; the latter, *Oxygen*.

To find the relative proportions of these two gases in air, we pour water into the jar nearly up to the brim, and then transfer it to a measuring cylinder. We read the volume of this water: it is 180 c.c. This evidently represents the volume of the air originally in the gas-jar. We then repeat the operation, but fill the jar only as far as the strip of paper. The measurement gives 142 c.c., and obviously corresponds to the volume of nitrogen left over.

The difference between 180 and 142, viz. 38, represents the volume of oxygen which combined with the iron.

Therefore 180 c.c. of air contained 142 c.c. of nitrogen and 38 c.c. of oxygen, so that the proportion is 142 : 38 or 4 : 1, approximately. Expressed in percentages, we should have:

180 c.c. of air contain 142 c.c. of nitrogen.

$$\therefore \text{ 100 c.c. } \text{,, } \text{,, } \frac{100 \times 142}{180} \text{ ,, ,,}$$

$$= \text{79 c.c. approx.}$$

Therefore, air contains 79 per cent. of nitrogen and 21 per cent. of oxygen by volume. More exact experiments give 79·1 and 20·9 per cent. respectively.

In addition to discovering that rusting iron takes up oxygen from the air, we have incidentally acquired some valuable information about the air itself. It is often thus in the art of discovery.

Experiment III.—*To find out if rusting iron combines with moisture.*

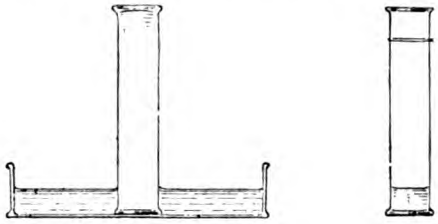


Fig. 1.

We collect some iron-rust, dry it in an oven, and place it in a dry glass tube sealed at one end. The other end is held with a pair of crucible tongs, and the iron-rust heated in the flame of a Bunsen burner (Fig. 2). We soon observe that steam comes off, that drops of water collect on the cold sides of the tube, and that the rust changes colour, becoming black. Since iron-rust parts with moisture on being heated, we may conclude that that very same moisture was taken up by the iron when it rusted.

We have now tracked the criminals—air and water. Do they act singly, or can they only act in collaboration?

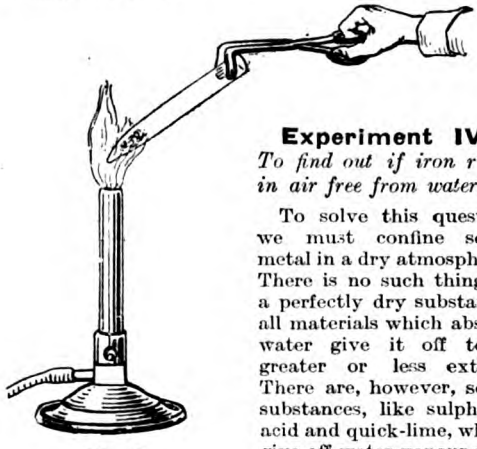


Fig. 2.

Experiment IV.—*To find out if iron rusts in air free from water.*

To solve this question we must confine some metal in a dry atmosphere. There is no such thing as a perfectly dry substance, all materials which absorb water give it off to a greater or less extent. There are, however, some substances, like sulphuric acid and quick-lime, which give off water-vapour only to an infinitesimal extent, and such materials are used by chemists to dry air and other gases. The vessel used for enclosing such drying agents and substances to be dried is called a *desiccator* (Fig. 3).

A common form of this apparatus consists of a round glass dish covered with a tightly-fitting dome-shaped cover. The drying agent is placed in the lower part, and the substance to be dried and kept dry—in this case the iron—is put on a watch-glass or porcelain dish supported on a wire or glass stand. After the lapse of months, and even years, it is found that iron so confined remains free from rust. Therefore, air alone is insufficient to cause rusting.

Experiment V.—*To find out if iron rusts in water without air.*

Since both oxygen and nitrogen dissolve in water to a slight extent, all ordinary water contains dissolved air, and so for the purpose of this experiment it will be necessary to expel the air contained in the water to be used, by vigorously boiling it for some time. We take a flask of about ¾-litre capacity, fill it about half full with water, place it on a piece of wire gauze supported on a retort stand, and then boil the water for fully ten minutes (Fig. 4).

When the heat is first applied, it will be noticed that moisture collects on the outside of the flask, and then small bubbles of air make their appearance, gradually rising to the top of the water and then escaping. The steam bubbles which subsequently escape will carry off the rest of the air which has not been expelled. After ten to fifteen minutes of vigorous boiling, a few pieces of bright iron wire are dropped in the water, and the boiling is then continued for a few minutes longer.

A tightly fitting rubber bung, or a cork previously softened and dipped in molten paraffin wax, is quickly inserted in the neck of the flask, care being taken that the water does not quite cease boiling during this operation. The flask is then allowed to cool, and it will be observed that the water continues to boil for some time although the temperature is well below its boiling point. When quite cold, the space above the water will be a very good—if not a perfect—vacuum.

Fig. 3.

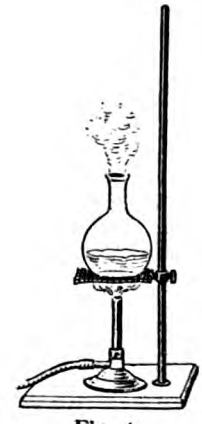


Fig. 4.

Treated in this way, the iron does not rust. In course of time it may show signs of discoloration; it may become black, but no rust will appear. Therefore, iron does not rust in water without air.

There are thus two accomplices in the crime of rusting—atmospheric oxygen and water; and each of these is impotent without the other.

When we discovered that rusting iron gains in weight, the metal was placed in an open vessel. It is interesting to inquire how the result would have been affected if the vessel had been closed instead of open.

Experiment VI.—*To find out if there is any change in weight when iron rusts in a closed flask.*

Some iron filings are put into a flask together with a little moisture, and then a well fitting cork is inserted in order to make it air-tight. The flask and contents are weighed. After a day or two, they are weighed again. If the flask has been air-tight, and the weighings accurate, the second weight will be exactly the same as the first.

Does this mean that the iron has not gained in rusting ?

No ; we have already discovered that iron gains in weight when it rusts, and this is true wherever the iron is. Why, then, have not the whole flask and contents gained in weight ? The answer is, that the air and water inside the flask have lost exactly as much as the iron has gained.

In Experiment I. the iron alone was weighed ; if we had weighed the surrounding air by itself it would have been found to have lost weight, because it gave up oxygen and moisture to the iron. So by weighing *all* the materials taking part in the change, both before and after, the total weight remains the same.

This is a very important fact, and one which will be referred to again very shortly.

Metal-corrosion, in particular that of iron, is a subject of very great importance in the world of industry and commerce. Not only does iron corrode when it is exposed on land, but at sea the action is just as important. In presence of sea-water, iron and steel corrode more rapidly than on land, because the dissolved salts cause galvanic (electric) action to be set up between them and any foreign metals present, even if only as impurities.

Rusting, like all forms of chemical change, is much accelerated by increase of temperature (the velocity of a change is approximately doubled for every 10° C. rise in temperature), and, therefore, in the bottoms of ships near the furnace-room and boilers this factor becomes of great importance.

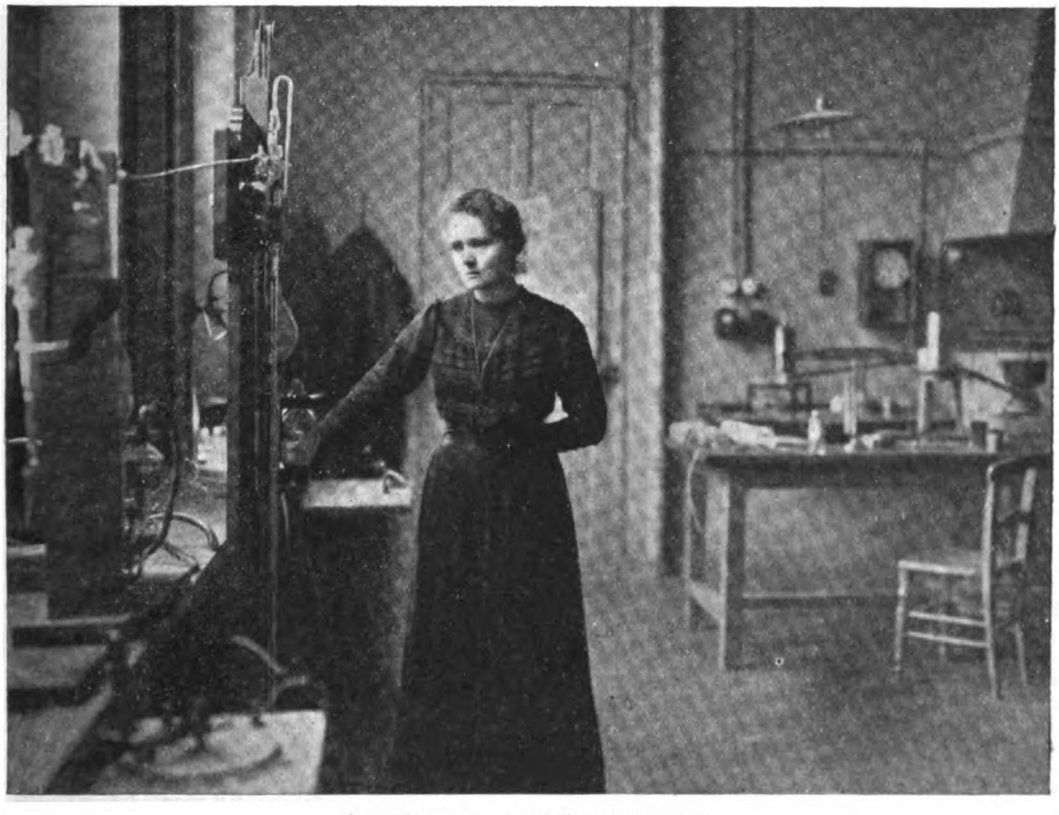
Methods of rust-prevention are very varied, but they are practically all based upon the same principle : the simultaneous exclusion of air and water. Of the metallic coatings employed, zinc, tin and nickel are the most important. Iron is " galvanised," or coated with zinc, by giving it a preliminary " picking " in dilute sulphuric acid, and then passing it on rollers through tanks of molten zinc, sal-ammoniac being used as a flux to keep the metallic surfaces clean. The galvanised plates are then washed in water and dried. Cisterns, buckets, wire netting, and such goods, are merely dipped after " pickling."

Tinning, or making tinplates, is an old industry which was introduced into South Wales in 1665 and is still very largely practised there. The plates of mild steel are pickled in sulphuric acid, annealed and rolled, and passed through a flux (zinc chloride) into the rolling mills, which contain molten tin.

The use of nickel plating on bicycles is familiar to all. As nickel does not adhere well to iron, an intermediate layer of copper is always used.

Of non-metallic coatings, the most important are paints, enamels, varnishes and cements, and for indoor purposes, black-lead and vaseline.

To remove rust, friction with paraffin-oil is to be recommended ; acids are to be avoided. E. H. T.



AT WORK IN HER LABORATORY.

Madame Curie the eminent French lady chemist, who, in 1902, introduced to civilisation the wonders of Radium.

HEAT.—I

1. Heat and Cold.—The terms *heat* and *cold* are ordinarily used in an ambiguous sense—meaning at one time the sensations themselves, at another the supposed external causes of those sensations.

In physical science, however, we use the term *heat* to denote the physical agent only. If this agent, or some of it, enter into us, we perceive the sensation of hotness: if heat pass from us, we experience the sensation of coldness. Heat, whatever its real nature may be, is thus a "something" which can pass from one body to another, and in ourselves induce the well-known sensations of heat or cold.

There is no need to suppose a further "something" called cold: *cold is merely the effect of loss of heat.*

2. What is Heat?—What is the nature of this familiar, yet elusive, Heat? This question must be as old as the spirit of inquiry itself, the effects of heat being as mysterious as they are omnipresent. The Greeks established heat as one of their four elements under the name of fire, indissoluble and fundamental; they perceived correctly, if dimly, its part in the formative work of Nature. Still no attempt was made even to speculate upon the ultimate essence of their element. Nor was this done until the Renaissance aroused the spirit of inquiry once more.

Slowly thereafter two distinct ways of regarding the nature of heat evolved into definite theories.

I. We notice first the idea that became very prevalent in the eighteenth century; namely, that heat is in reality a form of matter—a subtile, highly elastic and expansive fluid, so fine that it could penetrate among the ultimate particles of all other material bodies and readily flow from one body to another.

In order to explain such familiar phenomena as expansion, melting, etc., the heat-stuff, or *caloric* as it was called, had to be endowed with special properties; its particles were supposed to be attracted by other matter, but to be mutually repellent; and the fact that hot bodies are no heavier than the same bodies when cold made it necessary that caloric should be regarded as a *weightless* fluid.

II. There is nothing inherently absurd in this theory of heat; but one set of very familiar facts refuses to fit into it. Everyone knows that heat is always developed as a result of friction and that the supply of heat from this source is apparently inexhaustible. When two objects are vigorously rubbed together, both become hotter.

If heat is an indestructible and uncreatable material fluid, where does it come from, when a savage obtains fire by the vigorous friction of two sticks (Fig. 1), or when the piston of an air-syringe or bicycle-pump is energetically worked? (Fig. 2). If, on the other hand, heat is regarded as a mode of *motion*, the answer can readily be given: the heat is the equivalent of the motion which has been apparently destroyed. The science of the nineteenth century has taught us to regard *energy*, i.e. the power to impart motion, in the light of an objective entity, as real as—though quite different from—matter, and, like matter, capable of many transformations, but indestructible and uncreatable.

We shall give the full argument in a later lesson; at present it may simply be stated that all physicists now picture heat to their minds as *a form of energy consisting in the motion of the ultimate particles or molecules of bodies, which form of energy can be produced when other forms disappear, as in friction, and can be transmuted into other forms by suitable mechanism, as in the steam-engine.*

3. Sources of Heat.—The chief sources of heat on the earth may be simply classified as follows:—

(*a*) *From the Sun.* In this case the heat is simply transferred as such across the intervening space: no transformation of energy is involved in the process. Similarly the internal heat of the earth itself is conveyed to us, though by a different method.

(*b*) *Mechanical*, as in friction.

(*c*) *Chemical*, as in the case of the heat of a coal fire. When the two substances, carbon and oxygen, are separate, their atoms are said to have *potential* energy, i.e. energy which under proper conditions can be turned into motion, like that of a wound-up watch-spring. Now during combustion the carbon-atoms and oxygen-atoms combine, and their potential energy appears as heat. Many further examples of a similar kind could be cited from chemistry.

(*d*) *Electrical.* When an electric current passes through a thin metal wire or a carbon filament, as in our electric lights, the resistance it meets with causes some of the energy of the current to be transformed into heat, and the wire becomes white hot. In the arc-lamp the heat (and light) result from the energy expended in driving the electric current across the gap between the carbon rods; in this case the energy transformed into heat is great enough to vaporise some of the refractory carbon of the poles (Fig. 3).

Other minor sources of heat exist, but they are of no practical importance. They do not contradict the general statement that *heat always comes either from bodies already hot, or from the transformation of other kinds of energy.*

4. Effects of Heat.—The numerous effects of heat can be witnessed everywhere; but it will be convenient to classify them here.

(*a*) The most obvious effect of adding heat to bodies is that they become hotter; in other words, they become more able to impart heat to other bodies (§ 5).

We shall see later on that this is not a universal effect of heat; a block of ice, for example, can be heated for a long time, and will not become hotter, by any test that we can apply, until it is all melted. Moreover, equal additions of heat do not always produce equal additions to the degree of hotness, and the reason of this will also become apparent as we proceed. It is well, nevertheless, to realise at once that heat may be stored in bodies without becoming apparent to our senses or through our thermometers.

(*b*) A less obvious, but universal, effect of heat is *change of size*, usually in the direction of enlargement or expansion. In the case of solids and liquids

this expansion is small, but not negligible. We need only refer here to the gaps left between the successive lengths of the steel rails used for railways and trams to allow for expansion in hot weather, and to the rise of the mercury in a thermometer which is put in a warm place, for familiar examples of the fact.

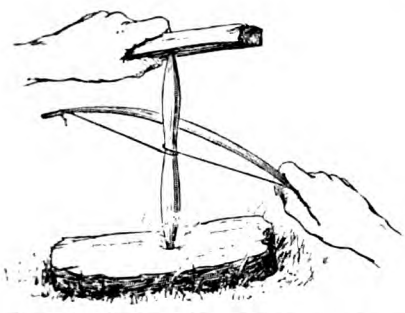


Fig. 1.—Production of Heat by the vigorous friction of two sticks.

But the expansion of gases is very considerable and perceptible. If an india-rubber bladder is blown up firmly and placed near a fire, its expansion—which is, of course, due to that of the air inside it — can be witnessed until the bladder bursts; and the fate of a pneumatic bicycle-tyre, left well blown up in a hot sun, is a reminder of the same fact. Sometimes we get contraction instead of expansion; ice, when changed into water by heat, contracts something like one-tenth of its bulk.

(*c*) Another effect of heat that occurs ultimately with all solid and liquid substances is a *change in physical state*. Any solid when heated will, sooner or later, become liquid. Some few solids are, indeed, so refractory that we have not yet succeeded in accomplishing the change in their case.

No degree of heat yet attained has caused lime, for example, to become a liquid; but we do not doubt that liquid lime could be formed, if we could make solid lime hot enough. The change we are now considering, it is to be remembered, is a physical change, or change of form merely. Ice and water are the same substance in different guise: we might describe ice quite fairly as solid water, or vice versa, water as liquid ice, according to our point of view, without incongruity.

Similarly, when liquids are heated, they begin to change into vapour, eventually to boil and resolve themselves completely into the gaseous form. Again, this is but a physical change. Steam is the same substance as water, only in another form. So other liquids, with a suitable degree of heat, boil and assume the state of gases.

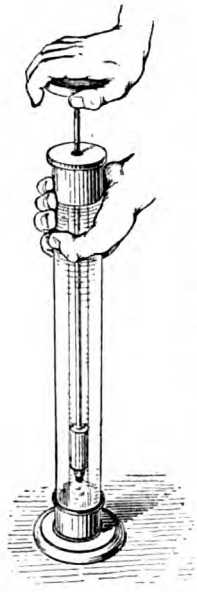


Fig. 2.— Generation of Heat by the working of a piston.

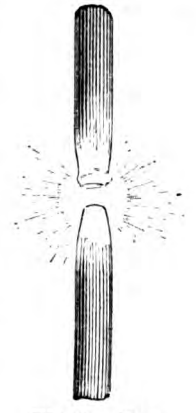


Fig. 3.—The principle of the arc light.

And observe: all these physical changes are reversible. Cool a gas, i.e. withdraw some of its heat, and it becomes liquid; cool a liquid sufficiently and it becomes solid. Even the so-called permanent gases, like air, become liquid and solid when they are sufficiently cooled. Thus water undergoes no permanent or fundamental change in becoming ice or steam; its changes are entirely dependent on the addition or subtraction of heat.

(*d*) Many substances, however, do not behave in this way. In the lessons on Chemistry many examples will be given in which heat resolves substances into new and simpler substances, quite different from the original substance. Potassium chlorate, for example, much used in the manufacture of lucifer matches, certainly melts when heated; but at the same time gives off oxygen gas, and on cooling a different substance, potassium chloride, is left behind. This is an example of *chemical change* produced by heat, and such a change is clearly not reversible, like the change from ice to water.

(*e*) Again, heat may play a rather different chemical part which is well illustrated in our common method of lighting a fire. The heat of the match-flame sets going the chemical action between the paper and the air, which action produces a still higher degree of heat, which in its turn sets going the chemical action between wood and air, and so on. Explosive substances give us another example of this use of heat.

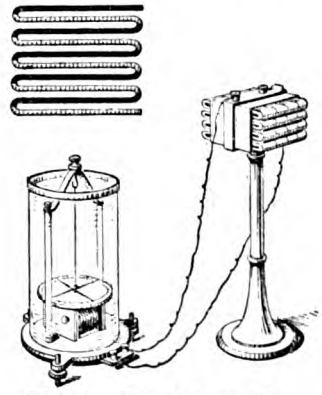


Fig. 4.—The thermo-pile.

(*f*) Still again: just as electric currents may develop heat, so under suitable conditions heat may set afoot electric currents. An instrument for doing this is the *thermo-pile* (Fig. 4). The essential features of this instrument are a series of alternate bars of antimony and bismuth, jointed as represented in Fig. 5. When the junctions *x* are heated, those at *y* being kept cool, an electric current would be shown by the indicator G. The current being small, the instrument has only a scientific interest.

(*g*) Finally, we refer again to the steam-engine or petrol-motor to remind our readers how the heat therein produced is converted into motion.

5. Temperature.—Temperature may be defined for the present as *that property of a body which determines the flow of heat from it.* Thus, if heat flows from A to B, A is said to be at a higher temperature than B. Now it is very important to realise from the outset that, though A may be at a higher temperature than B, it does not necessarily have more heat.

Just as one vessel may contain more water than another—though the level is the same—so one substance may have more heat than another though the temperatures are the same.

A practical example will help us to understand this more clearly. Suppose X and Y (Figs. 6 and 7)

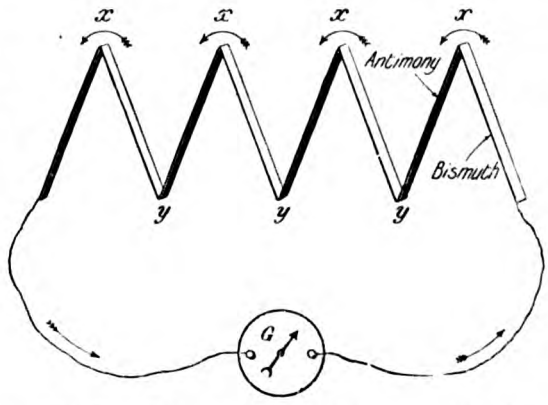


Fig. 5.—Diagram to illustrate the working of the thermo-pile.

exact and are often quite unreliable. Touch any half-dozen objects lying on the table. They are probably all at or very near the same temperature, but our sensations tell a different tale entirely. The silver penholder *feels* cold in comparison with the cloth pen-wiper. For our sensation depends on the flow of heat to, or away from, us; and if this takes place rapidly the sensation, whether of hot or cold, is quickly felt.

Silver is a good conductor and heat flows freely along it: hence the adjustment of temperature is more quickly made than in the case of wool, which is a bad conductor and impedes the easy flow of heat. In the next lesson we shall proceed to explain how temperatures can be reliably indicated and compared.

A hot body, placed in a cooler enclosure, cools gradually until

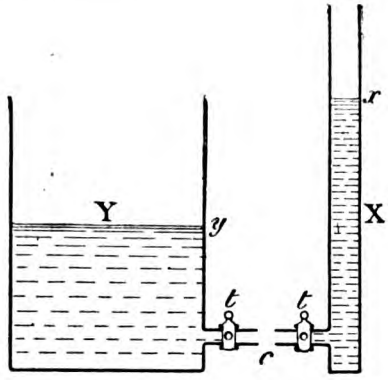


Fig. 6.

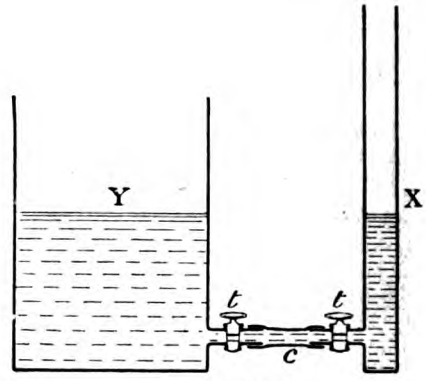


Fig. 7.

to be two vessels, containing water up to the levels *x* and *y* respectively, in which it is evident that Y may contain much more water than X. But if the two vessels are connected by an india-rubber tube at *c*, and the taps *t*, *t* opened, water will flow from X to Y until the level is the same in the two vessels; and when the levels are equalised, it is clear that Y contains much more water than X.

Now, temperature corresponds to the level of the water in this illustration. Heat will flow from one hot body to a cooler one (i.e. a body at lower temperature), until the temperatures are equalised. How much heat will thus flow is a question that depends upon many circumstances to be discussed later on.

In practical life we trust to our sensations to indicate higher or lower temperatures than that of our hand; but these sensations are by no means

it has the same temperature as the enclosure. This loss of heat, by the process called *radiation*, is not dependent on contact with the air or other material things, because it continues to take place *in vacuo*. The rate at which the temperature of the hot body falls, i.e. its rate of cooling, depends on various factors: it is greater from a blackened surface than from a polished one; it is more rapid the wider the gap of temperature between it and the surroundings; and the nature of the substance also enters into the matter: all substances do not lose equally in temperature, even though they may lose equal amounts of heat; e.g. about twice as much heat has to be taken from a pound of water to make it fall through an equal range of temperature with a pound of turpentine. How this is determined must be explained in a later lesson.

E. W. E.

ZOOLOGY.—II

" Is the gorilla a man and a brother ? "

The question must present itself to the mind of the student as he explores the classification of the animal world. There man is included with the rest of the animal kingdom. He is brigaded with the apes, the baboons, the monkeys, the lemurs, the marmosets, the aye-ayes, the galagos, the lorises, and tarsiers.

Are they akin to man—the appalling orang, the long-tailed monkey, the little animals externally resembling squirrels ?

They are all Primates, the pre-eminent mammals. Man is a mammal ; he is the master mammal, the pre-eminent Primate. He is not descended from the apes. Neither are apes descended from man. But, millions of years ago, two lines of ascent began from a lowly origin. Perhaps there was only one line.

One school of naturalists favours the idea of the double line of ascent ; a line which, they say, gave us, from the one root, the American monkeys and the marmosets ; the other root yielding the Old World monkeys, baboons, man-like apes, and man himself. The other theory—and this is the more generally accepted—is that all the Primates derive from one and the same root.

Existing Anthropoids

Dead ancestors of the gibbons—the smallest of the existing anthropoids—seem to furnish the link between Old World and New World Primates, and to dispense with the necessity for creating the theory of twin lines of ascent. Be that as it may, some lowly mammal, which wandered on all-fours, gave rise to higher forms which time, with its transforming hand, has fashioned into this greatest of all the animal groups—man and his savage, soulless duplicates.

The Primates, by reason of their resemblance to ourselves, are by far the most interesting and challenging of all existing animals. Structurally, the great apes differ from us only in degree, not in kind. The comparative anatomist knows that the apes resemble us almost bone for bone, muscle for muscle. Like man, they are tailless ; like him, they carry within their frames the vestiges of the tails that their ancestors bore.

Human organisms have undergone enormous changes to admit of man's discarding a quadrupedal, in favour of an upright, gait. Precisely similar changes have been effected in the organism of the great apes. They cannot speak, as we understand speech. Nor could primal man, judging from the evidences gleaned from the skull of the Piltdown woman, that newest treasure of ancient mankind, revealing to us an ape-like human being, heavy-jawed, small of brain, yet mentally far superior to any ape that has ever been discovered.

The brain of the anthropoid is smaller than that of the lowest savage, but it is built upon the same plan with our own. The movements of our limbs and muscles are controlled, in so far as voluntary muscles are concerned, by specific areas of the brain. Precisely the same effects are produced by the corresponding brain-areas of the anthropoids.

Man and Ape

The evidence in favour of the common ancestry of man and the anthropoid apes is overwhelming, but the subject may be better studied in detail under anthropological and anatomical headings. Suffice it to say here that while the anthropoids are subject to most of the diseases which afflict mankind, even—when kept in captivity—to appendicitis, there remains this further startling fact : nowhere throughout the mammalian kingdom is the counterpart of human blood found, save in the veins of a man-like ape.

The blood of man is practically indistinguishable from that of the man-like apes.

The hairiness of the apes is no barrier to relationship ; we have hairy races of human beings ; and all human beings of both sexes were at one time hairy. The fact that the apes and monkeys have four " hands " instead of two hands and two feet, as in the case of human beings, is part of the story of evolution. A human infant, with an elasticity of ankles and muscles unknown to adults, turns its feet inwards with the soles meeting each other, so that if it could, it would then walk after the fashion of an ape.

The Gorilla

Again, there are men in the East who, working with their feet, use the great toe for grasping implements ; and, finally, there are animals among the Primates which have not the opposable thumbs to the hind feet or hands, but use the fifth digit of each hind foot as a great toe, as we use ours.

The distinction between the feet of mankind and the feet of the anthropoids seems to be a product of that mighty revolution which was slowly wrought at the back of the mammalia's great beyond of misty millions of years, when the two lines began their great divergence. One section of the

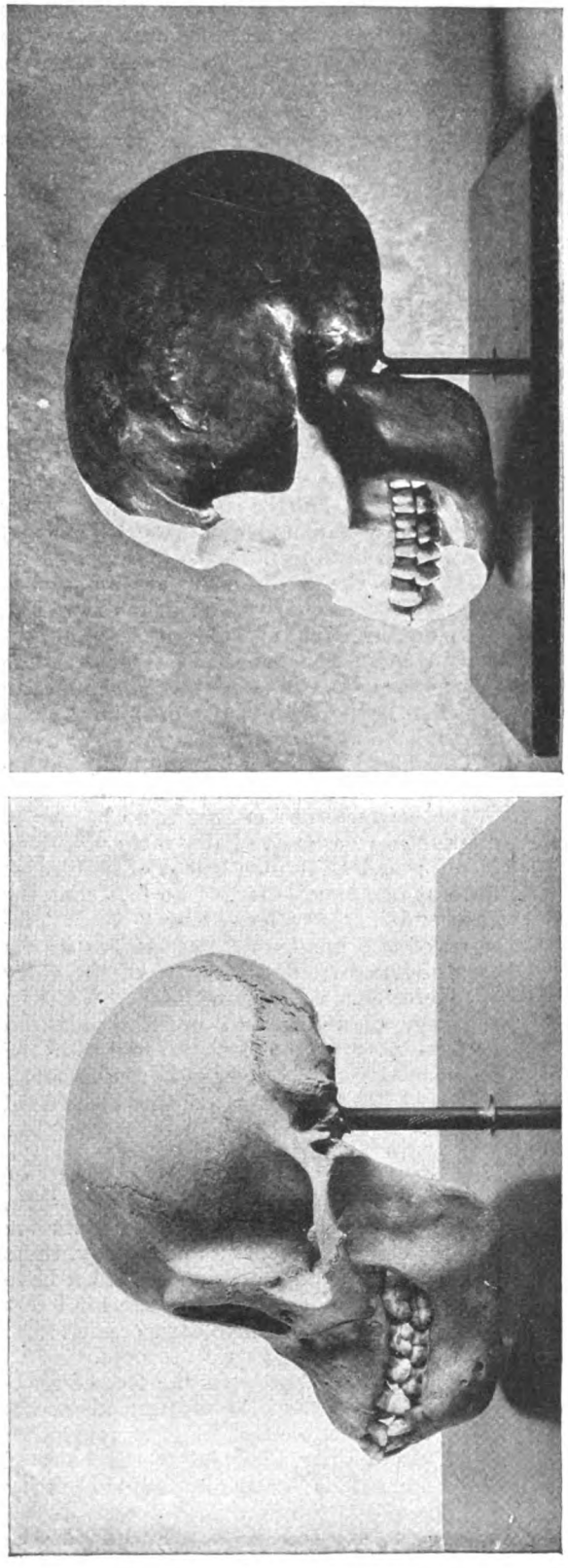


Photo by courtesy of the Natural History Museum

The Skull of a Chimpanzee (left) for comparison with the Piltdown Skull (right) as restored by Dr. Smith Woodward for the Natural History Museum, London.

Primates became definitely committed to life amid the trees, in which the anthropoids to this day remain. The other, more daring, forsook the trees.

The apes learned to walk upright amid the foliage of the forest giants. The humble progenitor of man learned to walk upright on the ground, and developed feet adapted to this form of movement; then, leaving the gloomy forest behind him, he began to wander through and master the world.

The highest of the apes remains, for all the resemblances, an appalling caricature of ourselves. The very young ape, which has not come into possession of the hideous bony masses which lower above the eyes of the adult animal, most closely resembles the earliest type of human creatures yet found.

But there are four types of anthropoids. Which most nearly approximates to ourselves?

In its uprightness of gait upon the ground, the gibbon is our closest copy. In general bodily structure and facial outline, notably in the young, the chimpanzee commands first place in the comparison. But the gorilla, most terrific of all, is nearest us in one or two important particulars.

The three largest of the anthropoids, when hurrying over the ground, use their long arms and hands as crutches, resting their doubled fingers on the earth and swinging themselves along as a lamed man swings himself by artificial aid. But the gorilla, when he advances to the attack, towers erect. He has the firmest footing of all the great apes, and he comes nearest to our shape in that he has developed the rudiments of calves, and bears his mighty frame with greater stability when upright than the others.

But, taking one consideration with another, it is the chimpanzee which, next to man, ranks highest in the scale of Primates,

and so must have first consideration. As we see the animal scrambling about at a Zoo, we do not realise that this wild denizen of the forests of West and Central Africa is five feet in height, and weighs as much as the average man—between ten and eleven stones. This is small compared with the gorilla, the male of which, when fully grown, weighs upwards of fourteen stones and attains a height of six feet, while giants of seven feet have been reported.

The anthropoids, in fact, do not look their size, for, compared with man, they are short in the leg, though extraordinarily long in the arm. In actual size of body, however, the apes are the larger. A six-feet gorilla, when seated, would appear to be five inches taller than an average man of the same actual height.

In a state of nature the chimpanzee dwells amid thick forests, where its food consists mainly of fruit and berries, eked out occasionally by reinforcements of luxuries snatched from the little clearings whence natives have moved to fresh woods and pastures new. In general, chimpanzees are inoffensive ; but if attacked they are formidable adversaries. Their teeth are their weapons, their hands being used to grasp the victim while a bite is inflicted.

Chimpanzee Humour

Livingstone, who had unrivalled opportunities of studying these animals in their native wilds, formed a high opinion of their intelligence, asserting that they discriminated between an armed and an unarmed man, attacking the bearer of a weapon, but treating the inoffensive superior cousin with indifference. Livingstone credited the chimpanzee with a rough humour, describing how the shrieks of one of his men, caught from behind by one of the animals, caused the ape to "giggle," and let him go unhurt.

Of the educability of the chimpanzee we have had numerous instances. Sally at the Zoo was a famous character, whose performances, carried out under the observation of Professor Romanes, are recorded in all the zoological literature of the world.

In the company of her trainer, Mansbridge, then head keeper of the apes, the writer saw successors of Sally achieve strikingly human tricks. Two of them fed each other with grapes, with milk, with bananas. They found apples and biscuits concealed in his pockets, opened a pocket-knife and cut up the fruit, broke up and divided the biscuits, obediently spat out stones and skins of grapes, closed eyes and opened mouths to "see what Jack will bring you," and finally, when taken back to their bedroom, screamed and howled like disappointed children.

The gorilla is a fascinating horror of almost

Photo: New York Zoological Society.

THE CHIMPANZEE.

Next to man ranks highest in the scale of Primates.

unmatched strength. It is not true that he clubs elephants to death, or that he carries women away captive. In the steaming depths of his twilight forest he dwells with his mate and offspring, of which latter, so far as is known, there is but one at a birth ; remote from the haunts of man and elephants,

still the great mystery of the woods. The mighty canine teeth, which resemble the incisors of lion or tiger, are purely defensive weapons; for the gorilla is a vegetarian, and takes his food upon the ground or in the tree-tops with equal facility. Despite his great bulk, the gorilla is a magnificent climber, ascending the tallest of trees capable of bearing his weight, and passing, if necessary, from one to another without descending to the ground. He climbs with a speed and dexterity amazing in so huge an animal, and has been known to leap unharmed to earth a distance from thirty to forty feet, and vanish like a sable shadow into underwood before the eyes of the hunter.

"Man of the Woods"

No adult gorilla has ever been captured; the strength and ferocity of the animal, under provocation, are too great. Many young specimens have been brought to London, but the difference in climate from that in which they were reared has always been fatal. Sufficient has been seen of them, however, for us to learn that they take with affection to children, play and romp with them in the most engaging manner, examine new objects with childish inquisitiveness, point with the index finger at things whose nature they appear desirous of fathoming, and generally behave with all the high-spirited charm and kindliness that experience of other hairy children of the wilds has taught us to expect.

Fate has made the orang-utan more easy of capture than the giant of west equatorial Africa, and rendered him, as a denizen of Borneo and Sumatra, more accessible to man. Structurally, the orang departs farther from, and yet comes nearer to, the frame of man than either of the two animals already considered. He has a central bone in the wrist which is absent from the wrists of man, chimpanzee, and the gorilla; he has the same number of vertebræ as man and the two other apes, but, unlike the latter, he has only twelve pairs of ribs, like ourselves, whereas they have thirteen. His ears are remarkably human; he has the eye of a born pickpocket, and much of his slyness.

The name of this animal, which is the Malayan for "man of the woods," indicates its habits. It is essentially arboreal, though it descends to the ground for food, and then, if attacked, will seize its assailant and bite off his fingers, lacerate his face with its terrible teeth, or otherwise maim him.

Upon the ground it is the slowest mover of the apes, for its knees are turned outwards, and it walks entirely upon the sides of its feet, with the knuckles undermost. In the trees, however, though deliberate in gait, it is a superb climber. With its sloping shoulders, its seemingly distorted legs, its protuberant abdomen and hideous mouth, the orang is the most repulsive of the anthropoids seen in captivity, yet in intelligence it certainly cannot be ranked lower than the chimpanzee.

There are two orang-utans at the Zoo at the time of writing. These have not been taught any tricks; for Mansbridge, their late keeper, although he never confessed it, was really a little afraid of them. They are monsters, and there is a terrible tale of Jacob, the greater rogue of the two, one day fastening, by means of hands and feet, such a grip upon him as to leave a serious record upon his ribs.

Darwin once saw a young orang deliberately use a piece of wood as a lever. The writer was shown a stout piece of wire which both these Zoo orangs had used for the same purpose. One tore the wire from the front of his cage, and passed it through the wires to the adjoining den, where the second ape, by the time the keepers arrived, had used it to such good purpose that he had stripped a considerable area from the frontal defences of his lair.

Revoltingly Human

It had long been known that young orangs which have offended will cover themselves over to avoid a smacking from their keepers, or even throw their arms around the keeper's neck and whimper a sort of appeal for pardon. One of the two adults in question, in the presence of the writer, preferred, when Mansbridge opened the door, to swing upon the latter, instead of taking the bowl of food offered to him. Mansbridge gently cuffed his head, whereupon the ape descended from his swing, stepped up to the keeper, shot out his huge lips, and kissed the man upon the cheek by way of reconciliation. It was a frightfully, revoltingly human act!

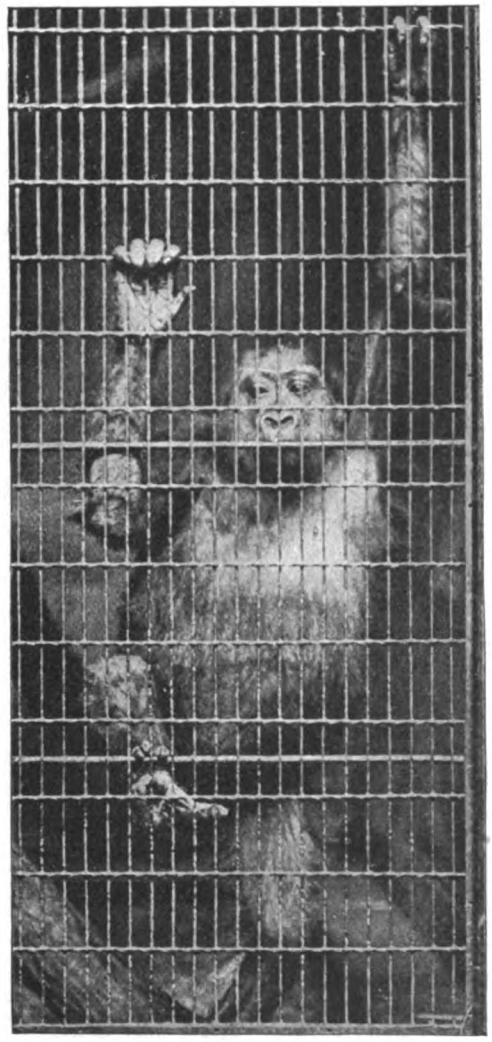
One of these orangs developed the habit of thrusting a straw through the front of his cage to reach a bowl of water placed in front. The second ape watched the trick and improved upon it. He thrust out four straws, soaked the ears in the water, withdrew them, and sucked the water from them. He did this repeatedly in the writer's presence. Generally the number of straws was four. If he got five it did not matter, if he got more than five the extra pieces were withdrawn, four remaining. It is fair to say,

THE MYSTERY OF THE WOODS.

The gorilla, a fascinating horror of unmatched strength. No adult gorilla has ever been captured. The stuffed specimen shown above belongs to the Natural History Museum, and is probably the finest that can be seen in Europe. As it stands, it measures 5 ft. 2 ins., and has a chest measurement of 47¾ inches. It was obtained from the great forest region to the west of Lake Tanganyika.

then, that this ape had learned, untaught, to count up to four.

The gibbons, of which there are eight species, are natives of the warmer parts of south-eastern Asia. They have the most upright gait of all the man-like apes, but they



IN CAPTIVITY.

Jenny, the young gorilla purchased by the Zoological Society in March, 1896, was the largest specimen ever imported alive. Jenny did not thrive in captivity. She died in August, 1896; she was then acquiring her permanent teeth.

are the smallest, the longest-armed, nearest to us so far as shape of head and face are concerned, but farthest from us in brain development. When on the ground they place their feet firmly, and, scuffling rapidly along, carry their arms above their heads as balancers, or employ them momentarily to grasp any object above which may help to steady them. This mode of locomotion is very striking to the student.

The real home of the gibbons is in the trees, where they advance, not by climbing, as is the fashion of their larger cousins, but by leaps and bounds, hanging by their enormously elongated arms, and leaping from tree to tree, thirty, forty, and more feet at a time, with such rapidity that as they launch themselves again and again, the eye cannot follow them. So swift and unerring are their flight and aim, that one has been known to catch a bird in mid-air with one hand, grasp a bough with the other hand, and then come instantly to rest upon the tree.

Unlike the other anthropoids, they go, as to several species of them, in troops, and acclaim the rising of the sun and the going down thereof with choruses of shrieks and yells such as chill the blood of a new-comer to their habitat. Their diet is a combination of vegetable and animal food. They eat fruit, leaves, buds, but they greedily devour insects and young birds.

In captivity they are the most dependable and docile of all the apes. One that Mansbridge trained at the Zoo had a little indoor gymnasium. This consisted of but a horizontal bar in a cage too small for " the grand circle," but the little creature, at the word of command, would grasp the bar, swing out, let itself go at full length where the space was sufficient; draw up its legs, and contract its arms where space was inadequate for its full length, then let itself out again to full stretch where the space permitted afresh.

There is yet much to learn about these humble copies of mankind, about all of them, but especially about the gorilla and the orang. We suppose their brain to be the equivalent in quality of that with which a child is born, but we underrate the apes. One of the orangs at the Zoo already referred to had a chain in his cage which he dexterously broke, carried to the roof, and used as a saw to cut through its wires.

He escaped and found refuge, and when pursued by his keeper, leaped down and violently shook the ladder by which the man had ascended, in the attempt to throw him off. The orang made his way into the grounds, and passed the night in a tree. In the morning it was found that the animal had made a nest in the tree, so settling a problem which had been debated for half a century as to whether these " wild men of the woods " really do form habitations in their native forests. **E. A. B.**

ASTRONOMY.—II

If anyone were to say: "I should prefer to have some experimental proof that the earth is actually moving. It does not appear to be so. How can you prove that it is really the earth which is turning on its axis and moving round the sun?": there are many proofs that may be alleged, among them the pendulum of Foucault, the shape of the earth, and the small displacement of the stars which is called the Aberration of Light.

Movement of the Earth

Foucault's pendulum may be seen in operation any day at the Science Museum, South Kensington. The pendulum is set swinging, and remains swinging in the same plane; the earth turns round underneath it, and the line of swing of the pendulum shifts upon the table. Should anyone object that it may be the effect of draughts, or of a slightly imperfect suspension of the pendulum, or of some similar cause of disturbance, the answer is simple. Perform the experiment anywhere you like, and you will find that the amount of the twist of the table under the pendulum corresponds very closely with what it ought to be according to theory, and the more precautions are taken to eliminate errors of experiment, the closer becomes the accord between theory and observation. The farther you go north the more quickly does it twist; only at the Equator is there no effect.

A single experiment at a particular place might conceivably be illusory. But when it can be performed again and again at very many places, and the result always fits in with the position of the place, and one never gets any results to contradict the theory, then one may become more and more firmly convinced that the theory is right. This is the way all experimental truths are established.

Displacement of the Stars

Our second proof, derived from the shape of the earth, is based upon evidence which is pretty strong. We know that if the earth were not perfectly rigid, or had not been always perfectly rigid, and if it was spun rapidly, it would bulge at the Equator. We know as a fact from surveys that the earth does bulge, and we can calculate that the amount of the bulge is just about what it should be if the earth turned round once a day. Again, there is nothing to contradict it, and the figures are all in favour of the assurance that the earth is turning on its axis.

Or take the third proof of the motion of the earth round the sun, which is more difficult, but even more conclusive. We know that light does not proceed through space with infinite velocity, for we can measure its speed in the physical laboratory and show that it is about 186,000 miles a second. We have measured the distance which divides the earth from the sun, and we know, therefore, that if it moves round the sun in a year it must be moving at the rate of so many miles a second—a speed which is small compared with the speed of light, but not altogether negligible. We can

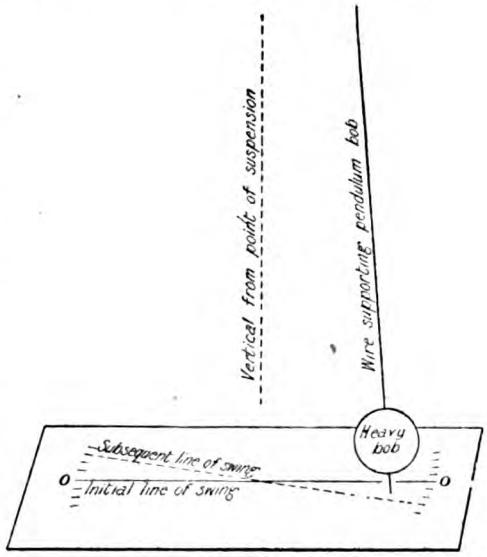


Diagram showing the action of Foucault's pendulum, by means of which the movement of the Earth can be proved.

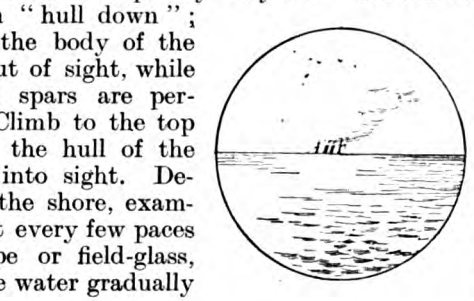
show—though the matter is too geometrical to be treated properly here—that the effect of this would be a small displacement of the stars towards that point of the sky towards which the earth is moving at the moment.

We compare the theory with observation of the places of the stars, and we find an agreement which is not contradicted by any known observation, so that again we conclude that the theory of the motion of the earth round the sun fits the facts. Evidence of this kind accumulates until at last, when we find twenty or a hundred facts all pointing to the reality of the motion of the earth, and nothing contradicting it except the mere evidence of our senses, which are so easily deceived, we are bound to believe that the theory is true.

We can deal in the same way with the proofs of the rotundity of the earth: a doctrine which was well established in the

time of the Greek astronomers at Alexandria, and which is susceptible of much easier proof than the doctrine of the motion of the earth.

The most obvious effect of the curvature of the earth is the manner of disappearance of a ship at sea. When one is close to the surface of the water a ship may very frequently be seen "hull down"; that is to say, the body of the ship has gone out of sight, while the masts and spars are perfectly visible. Climb to the top of the cliff and the hull of the ship will come into sight. Descend again to the shore, examining the ship at every few paces with a telescope or field-glass, and one sees the water gradually rising between the ship and oneself. One watches the disappearance of the ship inch by inch, until her hull is gone and her masts seem to be right in the water. There can be only one solution. The surface of the water must be curved.



Diagrams to illustrate the Rotundity of the Earth's Surface.

A more delicate observation of the same kind may be made at any place where it is possible to see the lights of a town across ten or fifteen miles of water. One may notice that the lights are sometimes visible from a given place and sometimes are not, and wonder how it is, until one remembers the rise and fall of the tide. Further, one may find that as one walks down a sloping path the lights disappear suddenly; and by going back a step or two one may find a place where raising or lowering the head by a foot will raise or extinguish the lights.

The only possible conclusion is that there is some material body coming in between, and cutting out the lights, which body can be only the curved surface of the sea. The experiment may be repeated all over the world, and one always finds results of about the same magnitude, from which it is evident that the curvature of the sea is not very different in different parts of the world, or that the earth is very nearly spherical.

In the district of the Fens, north of Ely, there is a long straight stretch of water known as the Bedford Level, which forms part of the great works undertaken a couple of centuries ago to drain the fen country and to turn it into its present condition of rich arable land. The waters of the Bedfordshire Ouse are diverted from their natural channel at Earith Bridge into a long embanked canal which runs nearly straight to the great sluice at Denver, near Market Drayton.

Between Welney and Denver there is an absolutely straight stretch of six miles, which has become celebrated as the most convenient place in England to put the rotundity of the earth to a test of figures; that is to say, to actually measure the curvature and to show by ocular experiment that the visible curvature is the same as the calculated.

Many sets of experiments have been made on this piece of water, of which one series in particular gained some celebrity from the fact that it was the subject of a public wager, resulting in a lawsuit in which the loser most unscientifically pleaded the Gaming Acts as a reason why he should not pay. Some fifteen years ago the experiment was repeated by Mr. Yule Oldham, one of the University Lecturers in Geography at Cambridge, and with his permission the results will be described briefly here.

On Denver Bridge a large white cloth was stretched, so that its centre was just fifteen feet above the water. On Welney Bridge a powerful camera was placed precisely at the same height. Midway between the two bridges a post was erected carrying a large white card, also at the same height of fifteen feet above the water. The camera was furnished with a very large tele-photo lens, which was necessary in order to secure the requisite magnification of the distant objects.

It was not an easy experiment to make, because one does not on every day in the year get the right conditions of light and atmosphere to make photography at such a distance possible; but after some delays and disappointment, the desired picture was secured, showing that the mark midway between the camera and the distant mark on Denver Bridge was raised nearly six feet above the line from Welney to Denver.

There is just one point to which attention should be directed: the refraction of the air, which raises all distant marks above their true position. It is easy to see that refraction will tend to counteract the effect of the real rotundity of the earth. In fact, if refraction were very much greater than it actually is, it would just succeed in masking the effect altogether. Happily, it is not

sufficient to do this, but it does very sensibly diminish it; and this has actually been used as an argument against the truth of the whole experiment, on the ground that the observed effect is not so great as would be expected if one had forgotten altogether the fact that there is refraction.

Proofs of the Earth's Rotundity

A proof which is often mentioned in textbooks is the fact that the shadow of the earth thrown upon the moon by the sun during a total eclipse of the moon has always a

The six miles stretch of water between Welney and Denver is the most convenient place in England to put the Rotundity of the Earth to the test of figures.

circular outline, which could not be the case if the earth were not spherical. It has always seemed to the writer that this, though undeniable, is not particularly obvious as it is generally stated, because at first sight it might seem to prove only that the earth is round, and might be flat, not spherical.

To complete the explanation, it is necessary to point out that eclipses of the moon occur at all sorts of times, and are visible sometimes from one side of the earth, sometimes from another. Sometimes the eclipse will take place at midnight in England; at another time at midnight in India; and another time at midnight in New York. With this amplification of the statement it does become evident that the earth must be spherical, or nearly so. But thoroughly to appreciate the reason demands already an understanding of the way the time varies in different parts of the earth; and this in itself supplies one of the most convincing proofs that the earth is spherical, or, at any rate, not flat.

In the old days, before the introduction of the submarine telegraph, we had not such convincing proof as we have now that time differs in different parts of the earth. How is it that when test matches are played in Australia the close-of-play scores appear in London soon after breakfast? How is it that the opening prices of the New York Stock Exchange come over to London just as the London Exchange is closing? It is not because there is a long delay in telegraphing, but because the time in Sydney is ten and a half hours ahead of, and the time in New York five hours behind, the time at Greenwich. When it is noon at Sydney it is about 1.30 A.M. in London, and the sun is below the horizon, while it is shining down on Sydney from its meridian passage. Such a circumstance must be impossible if the earth were flat.

As we sail from north to south we see each evening new stars appear above the horizon. The head of the Scorpion, which we see in English latitudes low down in the south in summer, rises nightly higher and higher as we go towards the Equator, while the body and tail of the creature

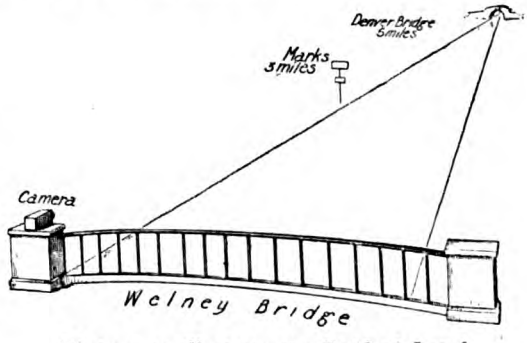


Diagram to illustrate the Bedford Level experiment (*see opposite page*).

come successively into view. One night someone familiar with the stars will point out the head of the Southern Cross just showing above the southern horizon. The next night the whole Cross may be seen; and as we go farther south the whole aspect of the sky changes. The old familiar constellations of the north are lost; whole constellations, which are never seen in the north, come into view.

The only possible conclusion is that we have, so to speak, gone round a corner: so that when we arrive at a point south of New Zealand, we see a whole sky completely different from that seen on the same night at the same hour in England.

Some of the constellations of the south are very brilliant, and on the whole, perhaps,

the southern sky is richer than the northern. But there is a certain lack of old associations which decidedly takes away from the interest of those constellations which are so far south that they were never seen by those ancients, in the plains of Chaldea, who seem to have given the northern constellations the names which are intimately associated with the astronomy of history and legend.

The Dodo, the Toucan, and the Peacock seem to be out of place in company with the Ram, the Lion, and the Goat, which have, from time immemorial, figured in the Zodiac. There are no heroes in the far southern sky to compare with Orion, Boötes, and Perseus, and there was some poverty of invention in the astronomer who filled up the spaces round the Southern Pole with the Octant, the Clockwork, and the Table. The old constellation figures play little or no part in modern astronomy, but their names survive to lend a pleasant flavour of antiquity.

There is a very simple rule for finding the limits of the constellations which may be seen at one time or other of the year from any particular place. At the North Pole, one would see the sky exactly down to the Equator, and no farther. Whenever the sun was absent, precisely the same stars would be seen moving round horizontally, and neither rising nor setting. As one comes south, the North Pole of the sky falls away from the zenith, and the Equator rises to the same amount above the southern horizon, so that some of the constellations south of the Equator come into view. Thus, the rule becomes self evident. One can see as far south of the Equator as the Pole is distant from the zenith. Or, to put it technically, the limit of south declination is equal to the co-latitude; that is to say, 90° minus the latitude of the place of observation.

On the Equator the two poles lie on the northern and southern horizons, so that at one time or other of the year all the constellations may be seen. As one goes beyond the Equator to the south, the constellations around the Northern Pole are, of course, gradually lost, and "the Bear which fears to dip into the sea" becomes at last perpetually submerged. It was precisely this observation, made by early travellers, that seemed to the early Greek astronomers the most conclusive proof of the rotundity of the earth.

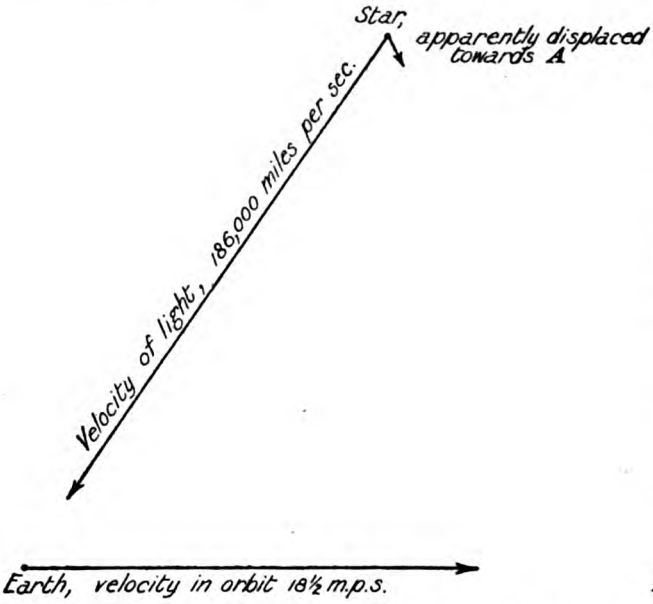
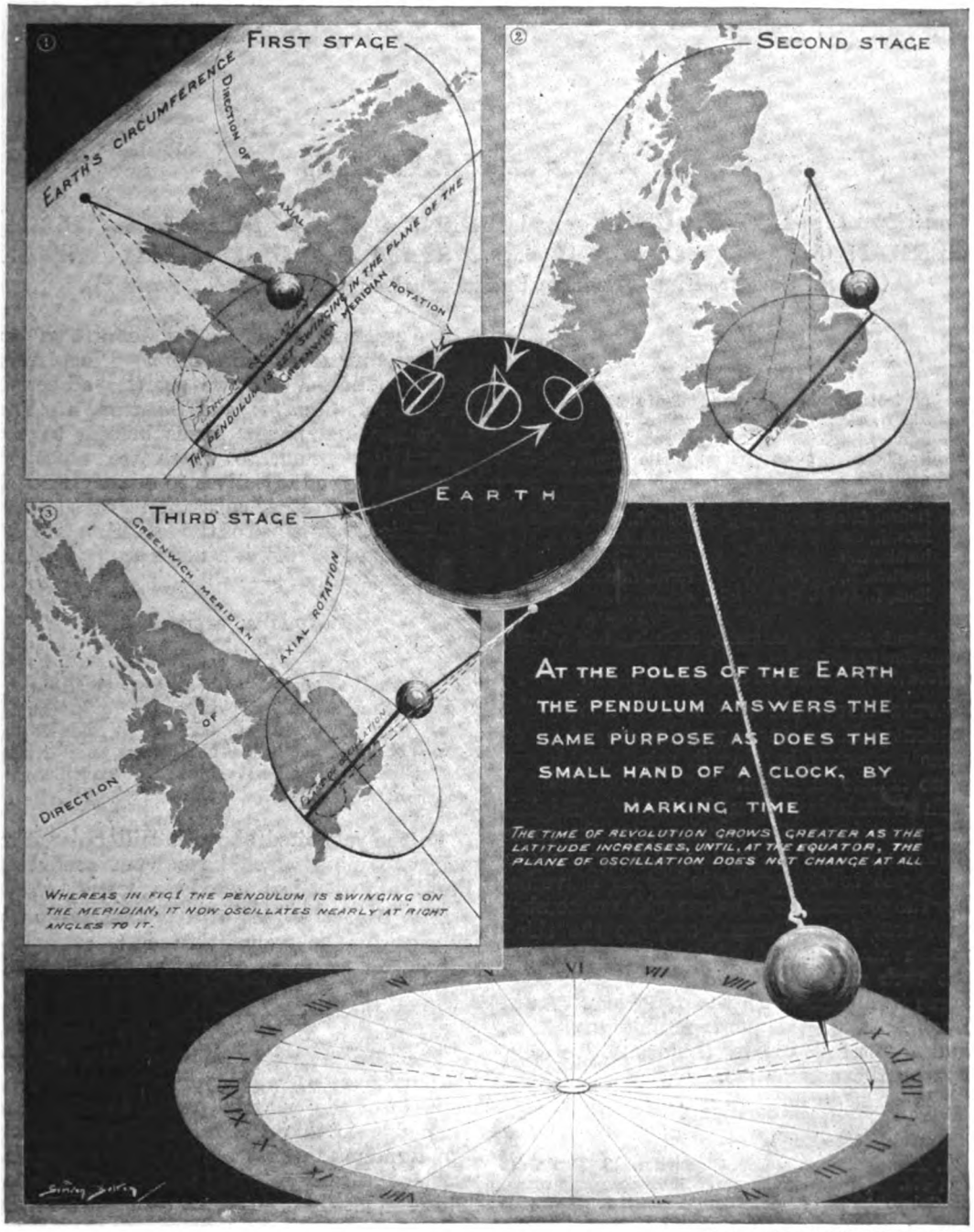


Diagram to illustrate the apparent displacement of Stars due to the Earth's rotation.

Just as it was with the evidence for the motion of the earth, so it is for the evidence of its rotundity. A whole series of facts point in the same direction; there is no single fact which contradicts the chain of evidence in any particular. All navigation, all surveying, depend upon tables which are calculated on the knowledge that the earth is round. Neither the navigator nor the surveyor in any part of the earth ever gets into any difficulty by the use of these tables, and there can be only one conclusion: the tables are based upon the truth.

It is of considerable importance to realise the strength of the evidence for such a doctrine as the motion of the earth and its rotundity, because from time to time one does meet with people of a peculiar turn of mind who have hit upon a single fact that they do not understand, and consider themselves justified thereby in doubting the truth of the whole body of astronomical knowledge. They have no conception of the way in which scientific facts fit together into a consistent whole; nor of the constant scrutiny to which the foundations of all scientific doctrine are subjected day by day. They are very apt to allege that scientific men are engaged in a conspiracy to uphold a theory they know to be false, but by which they live.

A. R. H.



From a drawing by Scriven Bolton.

HOW TO SEE THE WORLD GO ROUND.

A drawing illustrating diagrammatically the action of Foucault's pendulum, which may be seen in operation any day at the Science Museum, South Kensington, London. The pendulum is set swinging and remains swinging in the same plane, but as the earth turns round the line of swing of the pendulum apparently shifts. If the pendulum be made to swing for some hours, it will appear to have a rotary motion as shown in Figs. 1, 2 and 3. This is due to the fact that the world is rotating counter-clockwise—a movement in which the swinging pendulum does not participate.

Continued from page 37

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—II

VOCABULARY

agrĭcŏla, m., *husbandman.*	planta, f., *plant.*
āla, f., *wing.*	pŏēta, m., *poet.*
ăqua, f., *water.*	praeda, f., *prey.*
ăquĭla, f., *eagle.*	pŭella, f., *girl.*
cŏlumba, f., *dove.*	rāna, f., *frog.*
cōpĭa, f., *plenty.*	rēgīna, f., *queen.*
fĭgūra, f., *shape.*	rōsa, f., *rose.*
fīlĭa, f., *daughter.*	scrība, m., *scribe.*
insŭla, f., *island.*	silva, f., *wood.*
laetĭtĭa, f., *joy.*	terra, f., *earth.*
lūna, f., *moon.*	est, v., *is.*
	sunt, v., *are.*

Commit these to memory, declining half a dozen nouns for practice.

Note *filia* has dat. and abl. plural *filiabus.*

HAVING learnt the words given above, the student will be in a position to translate some sentences, bearing in mind that there is no article in Latin.

In translating from Latin into English you must insert the article where the sense requires it. As for verbs, it is much too early yet to study the inflexions of verbs. For the present it will be enough to remember that **est,** *is,* and **sunt,** *are,* are the third person singular and plural respectively of the verb **esse,** *to be.* As in English, they agree in number with their subjects. As in English, also, this verb is not transitive, and is not followed by the accusative case, but by the nominative.

Exercise 1

Translate into English :—

1. Ala aquilae. 2. Copia rosarum. 3. Poeta est agricola. 4. Filiae scribarum. 5. Plantae sunt rosae. 6. Columba est praeda aquilarum. 7. Luna est laetitia silvis. 8. Filia poetae est regina terrae. 9. Sunt ranae in insula. 10. Figura lunae.

Translate into Latin :—

1. Of the table. 2. Plenty of water. 3. The joy of the sailors. 4. The rose is the queen of plants. 5. The girl is the daughter of a poet. 6. The shape of the moon. 7. The scribes' table. 8. To the queen of the island. 9. The rose is a plant of the island. 10. The joy of the poet's daughters.

The inflexions apply to adjectives as well as to substantives. **In Latin the adjective agrees with its substantive in gender, number and case.** Thus from the base **bŏn-,** *good,* we get the adjective **bŏnus,** m., **bŏna,** f., and **bŏnum,** n. The masculine and neuter forms belong to the second declension, to which we must go for the forms of adjectives to qualify **nauta, poeta,** or any other substantive of the first declension that is not of the feminine gender. Here is an example of a noun and adjective declined together :—

Bŏnă pŭella, a good girl.

	Sing.		*Plur.*	
Nom.	bŏn-**ă**	pŭell-**ă**	bŏn-**ae**	pŭell-**ae**
Voc.	bŏn-**ă**	pŭell-**ă**	bŏn-**ae**	pŭell-**ae**
Acc.	bŏn-**am**	pŭell-**am**	bŏn-**ās**	pŭell-**ās**
Gen.	bŏn-**ae**	pŭell-**ae**	bŏn-**ārum**	pŭell-**ārum**
Dat.	bŏn-**ae**	pŭell-**ae**	bŏn-**īs**	pŭell-**īs**
Abl.	bŏn-**ā**	pŭell-**ā**	bŏn-**īs**	pŭell-**īs**

To the rule cited above it will be well to add two more which have been stated or implied in what has preceded.

The direct object of a transitive verb is put in the accusative case, the indirect or remoter object in the dative.

The Second Declension

The characteristic letter of the second declension is **o,** which precedes the final syllable of the genitive plural in all words belonging to this declension. In old Latin the termination of the nominative singular was **–os, dŏmĭnŭs** being written **dŏmĭnŏs.** This declension is not quite so simple as the first, instead of one uniform ending there being three, as follows :—

(1) Masculine nouns (with a few feminine, chiefly names of trees or Greek derivatives, and three neuters, **pĕlăgus,** *ocean,* **virus,** *poison,* and **vulgus,** *multitude,* the last sometimes masculine) ending in **–us.**

(2) Masculine nouns ending in **–er.**

(3) Neuter nouns ending in **–um.**

1. Dŏmĭnus (m.), *lord*, base, **domin–.**

	Sing.	*Plur.*
Nom.	dŏmĭn-**ŭs**	dŏmĭn-**ī**
Voc.	dŏmĭn-**ĕ**	dŏmĭn-**ī**
Acc.	dŏmĭn-**um**	dŏmĭn-**ōs**
Gen.	dŏmĭn-**ī**	dŏmĭn-**ōrum**
Dat.	dŏmĭn-**ō**	dŏmĭn-**īs**
Abl.	dŏmĭn-**ō**	dŏmĭn-**īs**

2. Ăgĕr (m.), *field*, base, **agr–.**

	Sing.	*Plur.*
Nom.	ăger	ăgr-**ī**
Voc.	ăger	ăgr-**ī**
Acc.	ăgr-**um**	ăgr-**ōs**
Gen.	ăgr-**ī**	ăgr-**ōrum**
Dat.	ăgr-**ō**	ăgr-**īs**
Abl.	ăgr-**ō**	ăgr-**īs**

3. Puer (m.), *boy*, base, **puer–.**

	Sing.	*Plur.*
Nom.	puĕr	puĕr-**ī**
Voc.	puĕr	puĕr-**ī**
Acc.	puĕr-**um**	puĕr-**ōs**
Gen.	puĕr-**ī**	puĕr-**ōrum**
Dat.	puĕr-**ō**	puĕr-**īs**
Abl.	puĕr-**ō**	puĕr-**īs**

4. Bellum (m.), *war*, base, **bell–.**

	Sing.	*Plur.*
Nom.	bell-**um**	bell-**ă**
Voc.	bell-**um**	bell-**ă**
Acc.	bell-**um**	bell-**ă**
Gen.	bell-**ī**	bell-**ōrum**
Dat.	bell-**ō**	bell-**īs**
Abl.	bell-**ō**	bell-**īs**

It will be noticed that in neuter nouns the nominative, vocative, and accusative are always alike. In the plural of all declensions these cases always have the termination **ă.**

In the first example ending in **–er,** which represents the normal form, the **e** is dropped in all cases but the nominative and vocative singular. It is retained in **ădulter,** *adulterer*, **gĕner,** *son-in-law*, **Lĭber,** *Bacchus*, or the *god of wine*, **lĭberi** (pl. only), *children*, **puĕr,** *boy*, **sŏcer,** *father-in-law*, and **vesper,** *evening*. With the nouns in -er must be classed **vĭr,** *man*, base, **vĭr–.**

	Sing.	*Plur.*
Nom.	vĭr	vĭr-**ī**
Voc.	vĭr	vĭr-**ī**
Acc.	vĭr-**um**	vĭr-**ōs**
Gen.	vĭr-**ī**	vĭr-**ōrum**
Dat.	vĭr-**ō**	vĭr-**īs**
Abl.	vĭr-**ō**	vĭr-**īs**

The locative survives in some words, e.g. **dŏmī,** *at home*, **hŭmī,** *on the ground*, and in the names of towns, as **Corinthī,** *at Corinth.*

A number of irregularities in this declension will be quoted later; here it will be enough to instance **fīlĭus,** *son*, **meus,** *my*, and **deus,** *god*, which are words of common occurrence. **Filius** has the vocative **fīlī, mĕŭs,** vocative **mī,** and **dĕŭs** is declined as follows :—

	Sing.	*Plur.*
om.	dĕ-**ŭs**	de-**ī** or **dī** (dii also occurs)
Voc.	dĕ-**ŭs**	de-**ī** or **dī** (dii also occurs)
Acc.	dĕ-**um**	dĕ-**ōs**
Gen.	dĕ-**ī**	dĕ-**ōrum** or (in poetry) de-**um**
Dat.	dĕ-**ō**	dĕ-**īs,** dĭ-**īs,** or di-**īs**
Abl.	dĕ-**ō**	dĕ-**īs,** dĭ-**īs,** or di-**is**

Having learnt the first two declensions of substantives, you will be able to decline all adjectives of three terminations, that is, adjectives which have a different form for masculine, feminine, and neuter respectively. The feminine follows the first declension, the masculine and neuter follow the second.

1. bŏnŭs, bŏnă, bŏnum, *good*, base, **bon–.**

Sing.

	Masc.	*Fem.*	*Neut.*
Nom.	bŏn-**ŭs**	bŏn-**ă**	bŏn-**um**
Voc.	bŏn-**ĕ**	bŏn-**ă**	bŏn-**um**
Acc.	bŏn-**um**	bŏn-**am**	bŏn-**um**
Gen.	bŏn-**ī**	bŏn-**ae**	bŏn-**ī**
Dat.	bŏn-**ō**	bŏn-**ae**	bŏn-**ō**
Abl.	bŏn-**ō**	bŏn-**ā**	bŏn-**ō**

Plur.

Nom.	bŏn-**ī**	bŏn-**ae**	bŏn-**ă**
Voc.	bŏn-**ī**	bŏn-**ae**	bŏn-**ă**
Acc.	bŏn-**ōs**	bŏn-**ās**	bŏn-**ă**
Gen.	bŏn-**ōrum**	bŏn-**ārum**	bŏn-**ōrum**
Dat.	bŏn-**īs**	bŏn-**īs**	bŏn-**īs**
Abl.	bŏn-**īs**	bŏn-**īs**	bŏn-**īs**

2. tĕnĕr, tĕnĕră, tĕnĕrum, *tender*, base, **tĕnĕr–.**

Sing.

	Masc.	*Fem.*	*Neut.*
Nom.	tĕner	tĕner-**ă**	tener-**um**
Voc.	tĕner	tĕner-**ă**	tener-**um**
Acc.	tĕner-**um**	tĕner-**um**	tener-**um**
Gen.	tĕner-**ī**	tĕner-**ae**	tener-**ī**
Dat.	tĕner-**ō**	tĕner-**ae**	tener-**ō**
Abl.	tĕner-**ō**	tĕner-**ā**	tener-**ō**

Plur.

Nom.	tĕner-**ī**	tĕner-**ae**	tener-**ă**
Voc.	tĕner-**ī**	tĕner-**ae**	tener-**ă**
Acc.	tĕner-**ōs**	tĕner-**ās**	tener-**ă**
Gen	tĕner-**ōrum**	tĕner-**ārum**	tener-**ōrum**
Dat.	tĕner-**īs**	tĕner-**īs**	tener-**īs**
Abl.	tĕner-**īs**	tĕner-**īs**	tener-**īs**

3. Pulcher, pulchră, pulchrum, *beautiful*, base, **pulchr–.**

	Sing.		
	Masc.	*Fem.*	*Neut.*
Nom.	pulcher	pulchr-**ă**	pulchr-**um**
Voc.	pulcher	pulchr-**ă**	pulchr-**um**
Acc.	pulchr-**um**	pulchr-**am**	pulchr-**um**
Gen.	pulchr-**ī**	pulchr-**ae**	pulchr-**ī**
Dat.	pulchr-**ō**	pulchr-**ae**	pulchr-**ō**
Abl.	pulchr-**ō**	pulchr-**ā**	pulchr-**ō**
	Plur.		
Nom.	pulchr-**ī**	pulchr-**ae**	pulchr-**ă**
Voc.	pulchr-**ī**	pulchr-**ae**	pulchr-**ă**
Acc.	pulchr-**ōs**	pulchr-**ās**	pulchr-**ă**
Gen.	pulchr-**ōrum**	pulchr-**ārum**	pulchr-**ōrum**
Dat.	pulchr-**īs**	pulchr-**īs**	pulchr-**īs**
Abl.	pulchr-**īs**	pulchr-**īs**	pulchr-**īs**

Several of the above nouns and adjectives should be carefully declined together according to the rules indicated, after which a second exercise can be done, the vocabulary given below having first been committed to memory.

Some remarks are necessary on the vocabulary. **Nōn,** *not*, and **saepe,** *often*, are adverbs and uninflected. **Mĭhĭ,** *to me*, and **tĭbĭ**, *to thee*, are the dative of the first and second personal pronouns. Pronouns are inflected, as will be duly set forth later on ; adverbs, prepositions, conjunctions, and interjections undergo no change.

In connection with **mihi** and **tibi,** a common Latin idiom may now be explained. *I have* and *thou hast* can be translated by using **est,** *there is*, or **sunt,** *there are*, with the dative. Thus **est mihi carus amicus** is, in idiomatic English, *I have a dear friend.*

The conjugations of verbs will be explained later : here it must suffice to note that the termination of the singular differs from that of the plural as in **dat,** *he gives*, **dant,** *they give.*

VOCABULARY

ămīcus, m., *friend.*
arma, n. (*plural only*), *arms, weapons.*
dăt, *he gives ;* dant, *they give.*
dĕcem, *ten.*
fĕcundus, -a, -um, *fruitful.*
fūnestus, -a, -um, *deadly.*
grātus, -a, -um, *pleasing.*
hăbet, *he has ;* hăbent, *they have.*
hortus, m., *garden.*
ignōtus, -a, -um, unknown.
in, with abl., *in ;* with acc., *into* or *to.*
Itălĭa, f., *Italy.*
magnus, -a, -um, *great.*
mĕus, -a, -um, *my.*
mĭhĭ, *to me.*
multus, -a, -um, *many.*
nōn, *not.*
oppĭdum, n., *town.*
pĕrĕgrīnus, m., *stranger.*
pŏpŭlus, m., *people.*
praemium, n., *reward.*
saepe, *often.*
servus, m., *slave.*
tĭbĭ, *to thee.*
vĕnit, *he comes ;* vĕniunt, *they come.*
vŏcat, *he calls ;* vŏcant, *they call.*

Exercise 2

Translate in English :—

1. Multae columbae sunt in insula. 2. Nullos amicos poeta habet. 3. Regina saepe in oppidum venit. 4. Servus ad dominum in tempore venit. 5. Agricola decem servos habet. 6. Dominus populum ad arma vocat. 7. Virum ignotum dominum vocant. 8. Multi peregrini in Italiam veniunt. 9. Meus amicus praemia pueris bonis dat. 10. Agricolae agros fecundos habent.

Translate into Latin :—

1. There are many strangers in the town. 2. My friend comes into an unknown land. 3. The daughters of the husbandmen are beautiful. 4. In the island there are great woods. 5. The lord calls the strangers into the town. 6. My friend calls the girl beautiful. 7. The queen gives great rewards to the sailors. 8. I have plenty of roses. 9. Thou hast a fruitful garden. 10. The arms of the strangers are deadly to the sailors.

NOTE.—In the sentences contained in this exercise or quoted as examples, it will have been noticed that the order of the words differs considerably from that usual in English. The order of words in Latin is governed largely by considerations of euphony, emphasis, etc., but there is a certain normal order. In the simplest form of sentence this is (1) subject, (2) object, (3) verb. In sentences a little more complex it is (1) subject, (2) indirect object, (3) direct object, (4) ablative, (5) verb.

E. A. B.

FRENCH.—II

The Definite Article has three forms :—

(1) **le,** used with masculine nouns.
(2) **la,** used with feminine nouns.
(3) **les,** used with plural nouns of either gender.

It has been noted already that the vowel of **le** or **la** is cut off or elided before a word beginning with a vowel or unaspirated **h.** The student will find words beginning with an aspirated **h** distinguished, usually by an asterisk, in the dictionaries. He will recognise them when they occur in these lessons or elsewhere by the unelided article, and should carefully commit them to memory.

Examples :—

le père, *the father.*	l'ami, *the friend.*
la mère, *the mother.*	l'homme, *the man.*
les frères, *the brothers.*	le hibou, *the owl.*

The Indefinite Article has two forms, **un** masculine and **une** feminine ; as in **un homme,** *a man ;* **un cheval,** *a horse ;* **une femme,** *a woman ;* **une plume,** *a pen.* The masculine and the plural definite article undergo contraction when they occur along with the preposition **de,** *of* or *from*, or **à,** *to.*

Examples :—

de le becomes du, as in du côté, *from* or *by the side.*
de les „ des, „ des hommes, *of the men.*
à le „ au, „ au roi, *to the king*, au hibou, *to the owl.*
à les „ aux, „ aux rois, *to the kings*, aux femmes, *to the women.*

The elided article prevents such contraction, as in **de l'oncle,** *of the uncle,* **de l'huile,** *of the oil;* **à l'enfant,** *to the child;* **à l'homme,** *to the man.*

There is no contraction when **le** or **les** is a pronoun; thus—**il vient de la faire,** *he has just done it,* **j'aimerais à les étudier,** *I should enjoy studying them.*

Partitive Sense.—The preposition with the definite article is used before substantives in a partitive sense, **du** or **de la** being rendered in English by *some* or *any,* or not rendered at all, thus: **du pain,** *bread* or *some* or *any bread,* **de la viande,** *meat* or *some meat,* **de l'argent,** *money* or *some money.*

Note that the vowels of **le, la,** and **de** are elided before **un** or **une;** thus, **l'un, l'une, d'un, d'une.** Later in this lesson it will be noticed also that the **e** of **je,** *I,* is elided before a word beginning with a vowel.

Gender.—There are two genders in French, masculine and feminine. Words denoting men and male animals naturally belong to the former, and those denoting women and female animals to the latter. But the names of inanimate things are also differentiated in the same way; thus, **le livre,** *the book;* **le bois,** *the wood;* **l'arbre,** *the tree;* **le papier,** *the paper,* are masculine; and **la table,** *the table;* **la plume,** *the pen;* **la feuille,** *the leaf;* and **la porte,** *the door,* are feminine.

Some rules will be given later that will help you to recognise the gender of nouns. For the present, you should be careful to observe the gender of the article prefixed to the nouns as you learn them.

Number.—There are two numbers in French as in English, the singular and the plural.

The plural is usually formed by the addition of **s** to the singular, as in the following: **un homme, une femme,** *a man, a woman;* **deux hommes, deux femmes,** *two men, two women.*

There are various exceptions to this general rule, as follows:—

(1) Nouns ending in **s, x,** or **z** remain unchanged in the plural, thus: **le bas, les bas,** *the stocking, the stockings;* **la voix, les voix,** *the voice, the voices;* **le nez, les nez,** *the nose, the noses.*

(2) Nouns ending in **au, eu,** or **œu,** together with the following nouns ending in **ou,** take **x** in the plural: **bijou,** *jewel;* **caillou,** *pebble;* **chou,** *cabbage;* **genou,** *knee;* **hibou,** *owl;* **joujou,** *plaything;* **pou,** *louse.*

Examples:—

le bateau, les bateaux, *the boat, the boats.*
le lieu, les lieux, *the place, the places.*
le vœu, les vœux, *the wish, the wishes.*
les bijoux, les cailloux, les choux, *the jewels, the pebbles, the cabbages.*
les hiboux, les genoux, les joujoux, *the owls, the knees, the playthings.*

Note that other nouns in **ou** take **s** in the plural, as **un bambou,** *a bamboo,* **des bambous,** *bamboos;* **un verrou,** *a bolt;* **des verrous,** *some bolts.*

(3) Nouns ending in **al** change this to **aux** in the plural, thus: **le cheval, les chevaux,** *the horse, the horses;* **le général, les généraux,** *the general, the generals.* **Bal,** *ball,* **carnaval,** *carnival,* **chacal,** *jackal,* and **régal,** *treat,* follow the general rule and form their plural by the addition of **s.**

(4) The following nouns ending in **ail** change this into **aux** for the plural: **bail,** *lease;* **corail,** *coral;* **émail,** *enamel;* **plumail,** *feather-brush;* **soupirail,** *air-hole;* **sous-bail,** *underlease;* **travail,** *labour;* **vantail,** *folding-door;* **vitrail,** *stained-glass window.*

Examples:—

les baux, les coraux, les émaux, *the leases, the corals, the enamels.*
les soupiraux, les travaux, les vantaux, *the air-holes, the labours, the folding-doors.*

(5) The following have irregular plurals differing in meaning from the plural that is regular in form: **l'aieul,** *the grandfather;* **les aieuls,** *the grandfathers;* **les aieux,** *the ancestors;* **le ciel,** *the sky, heaven;* **les ciels,** *skies* (in pictures), *bed-testers;* **les cieux,** *the heavens;* **l'œil,** *the eye;* **les œils** (only in compound words, as **œils-de-bœuf,** *bulls'-eyes, round windows,* **œils-de-perdrix,** *soft corns*); **les yeux,** *the eyes.* The student need not be discouraged by these irregularities. He will find it perhaps more profitable to refer back to them constantly rather than commit them laboriously to memory. Fluency comes from bold reading and writing.

Verbs.—That the student may be in a position to read or to write easy sentences, and begin at once to practise composition, it will be better not to adhere too closely to the logical treatment of our subject by grammatical classes, but to deal at this point with that essential part of every sentence, the verb. The more elementary tenses of the common verbs, **avoir,** *to have,* and **être,** *to be,* are conjugated as follows:—

Avoir, *to have.*

Indicative Mood

SIMPLE TENSES

Present

j'ai, *I have.*	nous_avons, *we have.*
tu as, *thou hast.*	vous_avez, *you have.*
il *or* elle a, *he* or *she has.*	ils_ *or* elles_ont, *they have.*

Imperfect

j'avais, *I had.*	nous_avions, *we had.*
tu avais, *thou hadst.*	vous_aviez, *you had.*
il avait, *he had.*	ils_avaient, *they had.*

Future

j'aurai, *I shall have.*	nous_aurons, *we shall have.*
tu auras, *thou wilt have.*	vous_aurez, *you will have.*
il aura, *he will have.*	ils_auront, *they will have.*

Conditional Mood

Present

j'aurais, *I should have.*	nous_aurions, *we should have.*
tu aurais, *thou wouldst have.*	vous_auriez, *you would have.*
il aurait, *he would have.*	ils_auraient, *they would have.*

Être, *to be.*

Indicative Mood

Present

je suis, *I am.*	nous sommes, *we are.*
tu es, *thou art.*	vous_êtes, *you are.*
il *or* elle est, *he* or *she is.*	ils *or* elles sont, *they are.*

Imperfect

j'étais, *I was.*	nous_étions, *we were.*
tu étais, *thou wast.*	vous_étiez, *you were.*
il était, *he was.*	ils étaient, *they were.*

Future

je serai, *I shall be.*	nous serons, *we shall be.*
tu seras, *thou wilt be.*	vous serez, *you will be.*
il sera, *he will be.*	ils seront, *they will be.*

Conditional Mood

Present

je serais, *I should be.*	nous serions, *we should be.*
tu serais, *thou wouldst be.*	vous seriez, *you would be.*
il serait, *he would be.*	ils seraient, *they would be.*

All tenses may be made interrogative in form by reversing the positions of the subject and verb, as in the following :—

PRESENT INDICATIVE OF **avoir**

Interrogatively

ai-je ? *Have I ?*	avons-nous ? *Have we ?*
as-tu ? *Hast thou ?*	avez-vous ? *Have you ?*
a-t-il ? *Has he ?*	ont-ils ? (m.) *Have they ?*
a-t-elle ? *Has she ?*	ont-elles ? (f.) *Have they ?*

The student should now learn the meanings of the following words, always paying great attention to the gender.

VOCABULARY

l'ami, *the friend* (m.).	le journal, *the newspaper.*
l'armée, *the army* (f.).	la lettre, *the letter.*
l'argent, *the money* (m.).	la maison, the *house.*
le banquier, *the banker.*	à la maison, *at home.*
la bataille, *the battle.*	merci, *thank you.*
bon jour, *good day.*	madame, *madam.*
le boulanger, *the baker.*	mademoiselle, *miss.*
demain, *to-morrow.*	mauvais, *bad.*
dimanche, *Sunday.*	la mère, *the mother.*
donnez-moi, *give me.*	monsieur, *sir.*
dans, *in.*	non, *no.*
l'école, *the school* (f.).	l'officier, *the officer* (m.).
et, *and.*	oui, *yes.*
l'épicier, *the grocer* (m.).	le pain, *the bread,* or *loaf.*
la fille, *the girl,* or *daughter.*	la peur, *fear.*
	la plume, *the pen.*
la fleur, *the flower.*	prêt, ready.
le frère, *the brother.*	prochain, *next.*
le garçon, *the boy.*	la sœur, *the sister.*
le général, *the general.*	le spectacle, *the play.*
la guerre, *the war.*	le temps, *the weather.*
l'homme, *the man* (m.).	toujours, *always.*
jeune, *young.*	la valise, *the portmanteau.*

Exercise 1

1. J'ai un père et une mère. 2. Bon jour, monsieur, je serai à l'école demain. 3. Avez-vous une lettre ? Oui, madame, elle est à la maison. 4. Donnez-moi un journal. 5. La jeune fille sera au spectacle. 6. Nous aurons la plume de l'officier. 7. Le temps est mauvais. 8. L'argent du banquier est toujours prêt. 9. Le garçon avait un livre et une plume. 10. Êtes-vous prêt, monsieur ? 11. Aurez-vous le journal dimanche prochain ? 12. Le père de la fille était à la maison. 13. Serez-vous l'ami du boulanger ? 14. Non, mademoiselle, je serai l'ami de l'officier. 15. La peur est un mauvais général. 16. Donnez-moi un pain. 17. Le frère de l'épicier est toujours prêt. 18. La mère du général avait une fleur. 19. Sera-t-elle à la maison demain ? 20. La fille et la sœur du banquier auront une valise à la maison.

Exercise 2

1. Have you a sister ? 2. No, I have a brother. 3. Will they be at home to-morrow ? 4. Yes, sir, and they will have a letter from the officer. 5. The banker's sister had the money. 6. Give me a newspaper and a pen. 7. Sunday next I shall be at the war. 8. The boy and the girl had a loaf. 9. The young girl always has a flower. 10. Thank you, miss, we shall be at the play. 11. The sister of the man will have a pen. 12. The friend will be at school to-morrow. 13. The letter from the general was in the newspaper. 14. The boy will be the friend of the officer. 15. The weather was bad. 16. The man's portmanteau is in the house. 17. The grocer's daughter is at home. 18. The girl had the loaf and the money. 19. The young boy had a pen. 20. Will they have a letter to-morrow ?

E. A. B.

Continued from page 42.

GEOGRAPHY:

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THE EARTH AS A PLANET

GEOGRAPHY is the study of the earth as the home of man. It is a review of the processes and conditions which have operated to make the world what it is to-day; and it is also the story of man's conquest of Nature.

The earth is interesting to us as a *human* planet; as the planet prepared by Nature for human habitation, and used by man to work out his own destiny.

The story of the earth's beginning is told by the science of astronomy, which traces the development of the globe from a thin incandescent nebula to a fast-rotating sphere, molten, semi-plastic, and beginning to assume its characteristic shape and rigidity.

Where astronomy ends, geology takes up the tale. By the study of the rocks themselves, and of the records left in them, we are able to trace the development of the earth-crust, to map out the shapes of vanished continents and oceans, and to re-people them with the forms of strange creatures and plants which have all formed links in the chain of evolution from the first specks of living protoplasm to the highest form of life—man.

Geography thus levies contributions on many sciences; it is, in fact, the common meeting-place of them all.

The Solar System

The earth on which we live is one of the smaller members of the Solar System—(Fig. 4) the family of planets revolving round the sun. Each travels in its own orbit, or path, with unerring precision, compelled to it by the mighty power of gravitation—the force that rules the universe. Much of man's work consists in devising means whereby this inexorable force can be cheated or defeated to man's advantage. The law of gravitation, however, has enabled man to foretell with remarkable accuracy, and centuries in advance, the exact positions of planets, the moments of eclipses, the appearance of comets, and many other matters which fall within the realm of astronomy.

The planets are compelled by gravitation to move in great ellipses round the sun. Each acts on all the rest; each is subjected to the gravitational pull of all the rest. The sun pulls, and is pulled by, all his family of planets. Planets nearest the sun feel his gravitational pull most strongly, hence their velocity is much greater than those which move round the sun in greater orbits. Neptune, farthest from the sun, travels about 3 miles per second; Venus, nearer the sun than the earth, has a velocity of 21 miles per second. The earth itself travels about 18½ miles per second.

Law of Gravitation

Not only distance plays a part in gravitation; there is also the *mass* of the bodies concerned. Newton's Law of Gravitation runs as follows: "Every particle of matter in the universe attracts every other particle with a force exactly proportional to the product of the masses, and inversely as the square of the distance between them."

The moon is the earth's satellite—a companion planet much less in size, which revolves around her in an almost circular orbit. We shall find that although she is much less in size than the sun, her nearness to the earth (240,000 miles) gives her a gravitational influence over the earth far greater than that exercised by the sun, whose mean distance is 93,000,000 miles.

Gravitation not only compels the earth and the planets to follow their orbits round the sun, but it prevents the planets from flying into space in myriads of fragments! For the planets rotate upon their axes at a speed which would cause all their particles to fly off at a tangent into space were it not for gravitation, which holds them to the centre about which they are grouped.

The earth (1) rotates upon its axis; (2) revolves round the sun; (3) with the rest of the Solar System is moving onward in space. The first movement takes about 24 hours to complete; the second a year of about 365¼ days. These movements have important geographical consequences which we must consider carefully.

The path of the sun in the heavens is the result of the earth's rotation upon its axis—the imaginary line upon which the earth turns. The "ends" of this axis are the North and South Poles respectively.

The result of the rotation of the earth is the phenomenon of day and night. For about 12 hours, half of the earth is turned towards the sun and has day; for the next 12 hours that half has night (Fig. 1).

If the earth's axis were upright in relation to its path round the sun, *i.e.* if it were perpendicular to the plane of the earth's orbit, the edge of the shadow would pass through the poles, and all places on the globe would have days and nights of equal length throughout the year. We know, however, that this is not so, *except at the Equator*. All other places have variation in the lengths of the days and nights, except on two days in the year—March 21st and September 23rd (the Equinoxes).

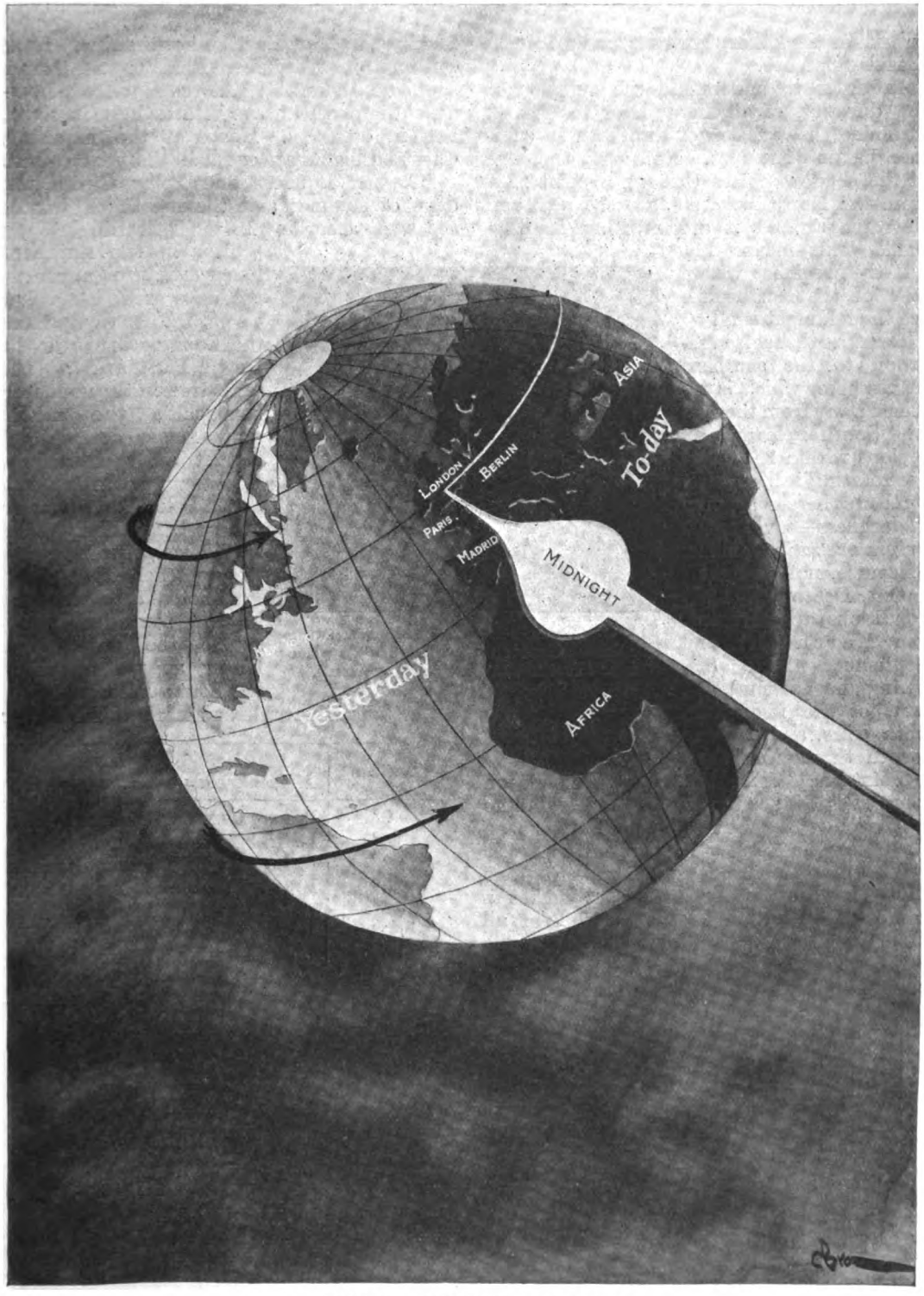
Variation in length of day and night is explained by the fact that the earth's axis is inclined at an angle of about 23½° from the perpendicular to the plane of the orbit. Consequently the edge of night-shadow does not pass through the poles (except on March 21st and September 23rd), but through points which are anything from 0° to 23½° from the poles. It depends on the time of year. This can best be explained in connection with the earth's other motion—the yearly revolution round the sun.

The earth's revolution, together with the inclination of its axis, explains the seasons. If we could view the earth's orbit from outer space, we should call it a circle. It is, however, not exactly a circle, but an ellipse. The important point about it is, that the sun is not at the centre of a circle, but at one of the foci of an ellipse. Consequently the earth is nearer the sun at one time of the year than it is at another. We are about 3,000,000 miles *nearer* the sun on January 1st than we are on July 1st! Yet in the northern hemisphere January is the coldest month, and July the hottest month! The explanation is simple, if the accompanying diagram be carefully studied (Fig. 3).

The northern end of the earth's axis always points in the same direction. In January the "tilt" of the northern hemisphere is away from the sun; in July it is towards the sun. Hence in January, those who live in the northern hemisphere are receiving the more oblique rays of the sun, and are consequently colder, although the earth as a whole is nearer the sun then than in July. The southern hemisphere, however, is receiving the more direct rays of the sun in January, and is experiencing summer. Similarly in July, the northern hemisphere is inclined towards the sun, and is having summer, while the southern hemisphere, inclined away from the sun, is having winter.

In spring and autumn the axis is pointing approximately in the direction of the earth's path, and both hemispheres enjoy similar conditions of light and heat in regard to the sun. The fact that winter has just passed in the one case, and that summer has just

Fig. 1.—Showing the British Isles at sunrise, midday, and sunset. As a result of the Earth's rotation on its axis, one half is turned towards the Sun for 12 hours a day; the other half during the other 12 hours.



THE MOVEMENT OF TIME

can easily be understood if one can imagine a fixed pointer under which the cities of the earth pass as the world rolls on from West to East. The drawing shows the pointer over London. The land to the East has already passed under the pointer, which in the drawing is supposed to leave a white mark. The lands to the West have still to pass under the pointer.

passed in the other, however, makes much actual difference.

In order to understand the question of the duration of daylight, refer to Fig. 3. Examine the position of the earth in summer, i.e. on June 21st. Note that the edge of the shadow passes through a point 23½° from the North Pole, so that the pole and the area around it are rotating in daylight. This means that all the regions within 23½° of the North Pole see the midnight sun!

Consider the facts in relation to the southern hemisphere, which is inclined away from the sun. The South Pole and all regions within 23½° of it are rotating in darkness. June 21st here is 24 hours of darkness—save for the *aurora australis*, which is, of course, not sunlight.

On December 22nd conditions are reversed. On March 21st and September 23rd (i.e. spring and autumn), the edge of the night-shadow passes through both poles, and day and night are of equal length throughout the world.

Points 23½° from the North Pole lie on what is known as the Arctic Circle. Points 23½° from the South Pole, similarly, lie on the Antarctic Circle. A point on the Arctic Circle rotates within daylight on June 21st; but on December 22nd it makes a complete revolution in the dark. On all other days it will have day and night, the days gradually shortening from 24 hours on June 21st to nothing on December 22nd; and gradually lengthening from nothing on December 22nd to 24 hours again on June 21st. At the Equator, however, the earth always rotates half in light, half in darkness. Hence at the Equator, days and nights are equal all the year round.

Between Equator and Polar Circle the days of summer and the nights of winter are long, according to the latitude.

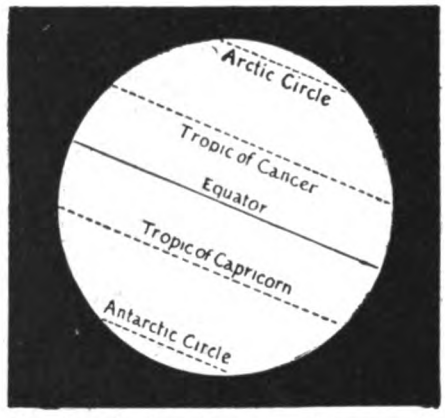


Fig. 2.—Outside the area between the Tropics of Cancer and Capricorn no place ever has the sun vertically overhead.

Thus in the northern hemisphere, in summer, the days grow longer as we get farther away from the Equator towards the North Pole, and at the same time in the southern hemisphere the nights grow longer as we get farther away from the Equator towards the South Pole. In winter in the northern hemisphere the nights grow longer as we approach the North Pole, and at the same time in the southern hemisphere the days grow longer as we approach the South Pole.

The following table summarises the facts:

Latitude	*Length of Midwinter Day*	*Length of Midsummer Day*
0°	12 hr. 6 min.	12 hr. 6 min.
10°	11 hr. 30 min.	12 hr. 38 min.
20°	10 hr. 52 min.	13 hr. 18 min.
30°	10 hr. 10 min.	14 hr. 0 min.
40°	9 hr. 16 min.	14 hr. 58 min.
50°	8 hr. 0 min.	16 hr. 18 min.
60°	5 hr. 44 min.	18 hr. 44 min.
66½° to 90°	0 hr. 0 min.	24 hr. 0 min.

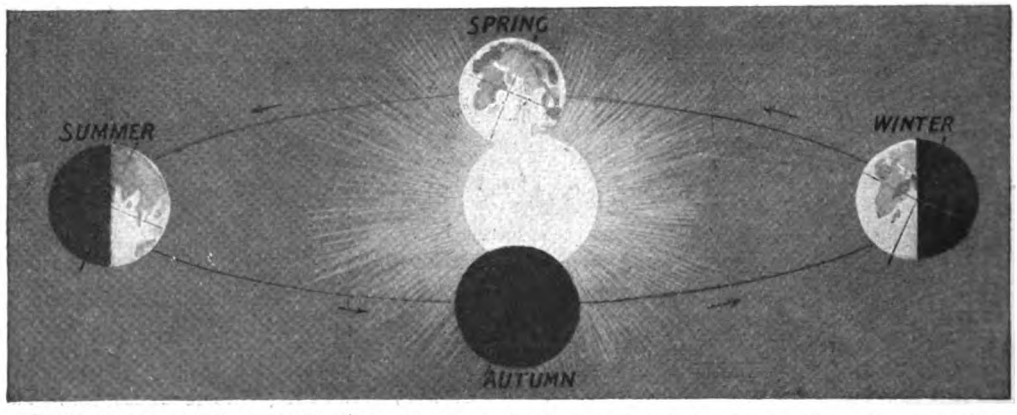


Fig. 3.—Demonstrating the Earth's path round the Sun and explaining why winter is colder than summer, although in December Britain is 3,000,000 miles nearer to the Sun than in June.

We have all learned from our own experience that the sun is highest in our sky on midsummer day at noon, and that his smallest noon altitude is on midwinter day.

Refer again to Fig. 3. Examine the position of the earth in spring, *i.e.* on March 21st. Note that the Equator rotates so that it receives vertical sun-rays at noon.

Similar conditions prevail in autumn, *i.e.* on September 23rd. Now examine the case for June 21st, when a line parallel to the Equator, and 23½° *north* of it, has vertical sun-rays at noon. Similarly on December 22nd, a line 66½° *south* of the Equator, and parallel to it, has vertical noonday sun. Outside these lines, no place ever has the sun vertically overhead. These lines are the Tropic lines—the Tropic of Cancer to the north of the Equator; the Tropic of Capricorn to the south of it.

From March 21st the line of vertical noonday sun gradually passes northward, until on June 21st it is at the Tropic of Cancer—its northernmost limit. From June 21st the line of vertical sun-rays passes farther south each day, until on September 23rd it is again at the Equator. From September 23rd it is gradually moving south, until on December 22nd it coincides with the Tropic of Capricorn—its southernmost limit. After December 22nd it moves north again, until it is at the Equator on March 21st (Fig. 2).

The Five Climatic Zones

A study of the table below will help to make this clearer. The latitude in each case is that of the parallel over which the sun is vertical for the day stated.

Date	*Latitude*	*Date*	*Latitude*
Mar. 21	0°	Sep. 23	0° S.
Apr. 1	5° N.	Oct. 1	3° S.
May 1	15° N.	Nov. 1	14° S.
June 1	22° N.	Dec. 1	22° S.
June 21	23½° N.	Dec. 21	23½° S.
July 1	23° N.	Jan. 1	23° S.
Aug. 1	13° N.	Feb. 1	17° S.
Sep. 1	8° N.	Mar. 1	7° S.

We have now five important lines—all imaginary-fixed astronomically, and marking out the five climatic zones. They are the Equator, passing round the middle of the earth, the Arctic and Antarctic Circles parallel to the Equator and 23½° from the poles; and the Tropics of Cancer and Capricorn, parallel to the Equator and 23½° north and south, respectively, from the Equator.

R. F.

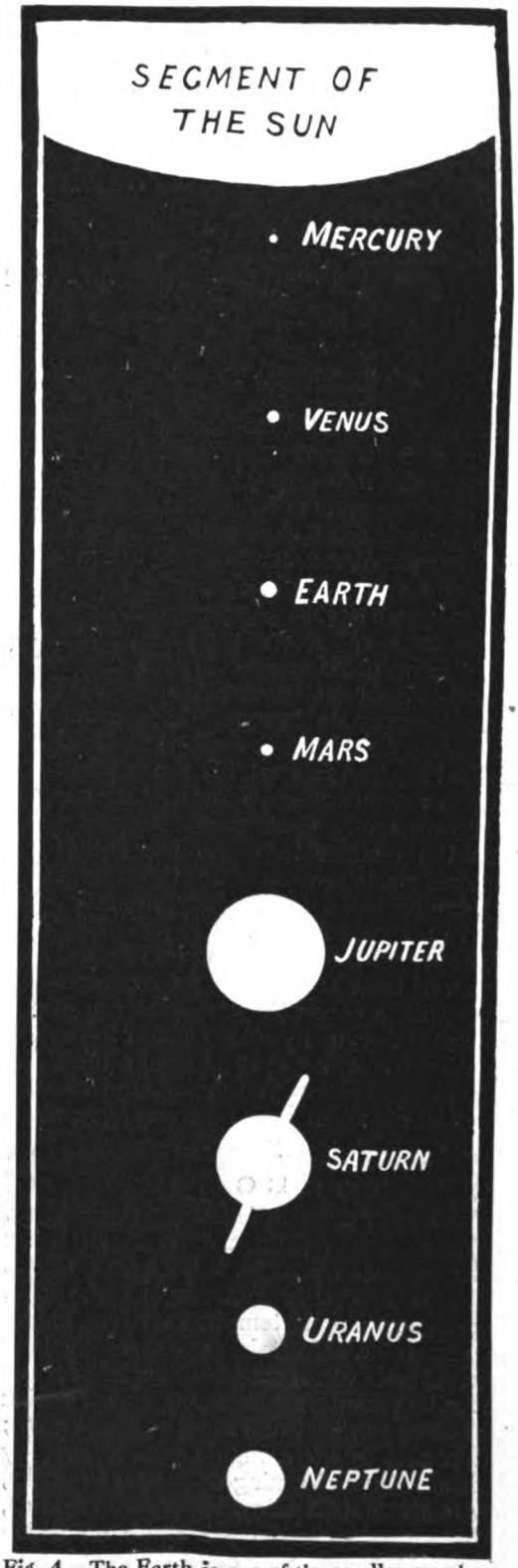


Fig. 4.—The Earth is one of the smaller members of the family of planets revolving round the Sun.

Continued from page 50.

ART AND MUSIC:

***Contributors*:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).**

DRAWING.—I

DRAWING, like all branches of art, is a means of individual expression. You draw a certain object in the especial and individual way in which you see it. There lies a difference, though sometimes it is a very small one, between your aspect of a house or a rock and everybody else's aspect of it. So it is when we regard the work of a master, we do not say, "How like a house that is!" but, "How characteristic is that house of So-and-so's work!" As a matter of fact, you frequently do hear people in some picture gallery saying, "How natural! How lifelike!" The appeal of the picture to them is not an artistic appeal. The subject of the picture is what interests them. But it is the manner in which the subject is rendered which appeals to the discerning eye, which looks for the expression of the artist's personal feeling.

You draw, then, because you must. You have an insatiable craving to express on paper with a pencil the particular sensations aroused in you by the sight of—say—a beautiful house, a beautiful tree, a beautiful face. But before you can express the beautiful object in your own way, you must learn the elementary rules.

The A B C of Art

The love of drawing is born in many of us. We think how delightful it is to sit down and reproduce on paper this or that object which is especially pleasing to the eye. Thus there is a great temptation to run before we can walk. To take a simple analogy from sport, you cannot score a goal at football without first learning how to kick the ball in the best and most effective way; you cannot knock a man down, except by chance, without learning first how to strike, how to put weight into your blow. And so, without mastering the principles on which the art is based, you cannot draw. Now and again, quite by chance, you may succeed in some particular direction. But it is a perfectly safe rule to follow, that all art students should begin at the bottom and learn the A B C of drawing before allowing their ambition to carry them away. The speed of their progress will be measured by their power. The man or woman with genuine aptitude and talent will speedily master the elementary rules. But—and this should be most emphatically remembered—the older a good artist grows, the more adept he becomes, the more he will rely upon and seek guidance from the old, simple rules. Those who do not, those who consider themselves above the rules of proportion, perspective, and so on, are the failures. Sometimes they may in part make up for their lack of draughtsmanship by their fine sense of colour; but colour without form is much the same as blankets without a bed. The blankets are useful alone, but to fulfil their purpose well, they must have a bed to be laid on.

Man's Creative Faculty

"Great things," writes Mr. Harold Speed, the well-known portrait painter, "are only done in art when the creative faculty of the artist has a well-organised executive faculty at its disposal."

That is, it is not sufficient to be able to invent: you must know how to work up to your invention. An engineer may have a splendid and perfectly new idea for building a bridge, but he cannot put his idea into practice unless he understands the principles of engineering. Moreover, it is safe to say that without the preliminary knowledge he would never have the brilliant idea.

Nevertheless, as Mr. Speed points out, "There is undoubtedly a danger that too much knowledge and training may supplant the natural intuitive feeling of a student, leaving only a cold knowledge of the means of expression in its place." But that point of view, though it should not be forgotten, can wait for amplification till a later chapter.

Materials: Their Use.—To begin at the beginning you must, before attempting to draw, understand what materials are necessary and how these should be used; how to make the best of them. The essential materials for free-hand drawing (which is drawing without the employment of guiding instruments, such as compasses or rulers) are four in number: pencil, paper, india-rubber, a drawing board. The last of these you should have from the start, because drawing on odd scraps of paper placed on a book or table is inclined to bring you into slovenly habits. The good workman, it is always being said, should not complain of his tools; but the good workman needs good tools, and knows that it is more economical in the end to have them.

The best sort of board to get is made of deal or pear-wood, and in size it is about twenty-three inches by sixteen inches. This will take half a sheet of Imperial paper, which should be the "cartridge" paper made for the purpose.

It is as well to say here that the simplest of elementary studies should be drawn big—the bigger the better. This will ensure good practice in *line*, which we shall come to presently, and will give too much room for any slurring over of detail. A plain large drawing can be seen all at once; and if there is anything wrong with it, you will be able to discern the mistake immediately.

For the sake of convenience, drawing books can be used instead of single sheets. These can be obtained in large sizes, together with your other materials, from a stationer or artists' colourman.

The pencils usually recommended are those marked HB, B, and BB. The HB is a fairly hard pencil and should not be too recklessly used at first, because the line from it, if hard pressed, is difficult to rub out. The B is quite soft, the BB very soft indeed.

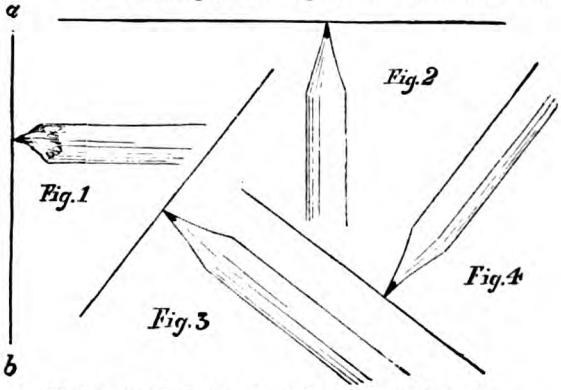
You should employ the B first of all for touching in the general idea of the study you are making, for marking the proportion of one object to another or one part of an object to another part. If you make a false stroke you can easily erase it, though it is well to remember never to press too hard upon any pencil. In trying to rub out a hardly made line you will generally roughen and eat into the surface of your paper. Moreover, quite apart from actual mistakes, the first touching in should be light, as you will want to rub it all out save for a scarcely perceptible outline over which the finished drawing is made with the HB. This latter gives a perfectly clear, clean line, which is much less prone to be rubbed or smeared or made obscure in the process of time than lines made with the B and BB.

There is a harder pencil still—the HH—but this will not be required for elementary free-hand drawing, being used for geometrical drawing with instruments. The B, being soon worn down by rubbing on the paper, is useful for shading. The actual method employed for this will be fully explained when we come to that subject. The BB is for getting the effect of very deep shade and masses of black.

It is exceedingly important that a really sharp knife be used for cutting your pencils. The well-sharpened pencil comes to a gradual, even point as in the illustration (Fig. 2). Fig. 1 displays the untidy, carelessly cut point. Your india-rubber should be very soft and as pure as possible. Good rubber for drawing purposes may be procured from stationers at a small cost.

When not using a drawing book, you should pin your paper on to the board at the four corners. The best drawing pins will well repay their price. These have a serrated edge like a coin and are withdrawn from their places with comparative ease. If you use pins without rough edges you are liable to break your nails, bend the pin itself, and discover that in this as in other matters a penny wise is a pound foolish.

Whilst writing of drawing boards it should be said that they should be provided with cross pieces at either end into which the main board is mortised. This prevents warping, and gives the board a more finished and workmanlike appearance.



HOW TO HOLD AND SHARPEN A PENCIL.
Fig. 1 shows how not to sharpen a pencil; Fig. 2, how to sharpen a pencil; Fig. 1, position of pencil for drawing perpendicular line *a*–*b*; Fig. 2, for drawing horizontal line; Figs. 3 and 4, for drawing inclined lines.

Besides merely pinning the paper down at its corners, there are two methods of fixing the paper which will be found extremely useful.

The simpler of these is to cut your paper exactly the same size as your board. Turn up this margin evenly along the four sides and cut the corners diagonally, so that these margins may stand up evenly and form a kind of tray. Now you should thoroughly damp the paper on both sides with a sopping wet rag or sponge. You should then paste the upturned margins on their outer side. Flour paste, well boiled, is the best to use. You should now leave the paper for a little while to expand through the wetting it has received, and then lay it carefully on your drawing board, pressing down the pasted margins so that they stick. This can be done the more easily with the use of a piece of writing paper, or newspaper folded two or three times and held evenly over the margin. If you press with your fingers alone, you are apt to wrinkle or perhaps tear the damp paper. When you have done this, wet the paper again a little, and leave the board until dry.

The result of this is that you get a perfectly level and even surface on which to draw; for, as it dries again, the paper contracts and pulls away from the pasted margins, evenly on all four sides.

The other method of stretching your paper is to cut it about two inches wider and longer than your drawing board, to damp all but the margins and to draw these over to the back of the board, where they should be pasted down, or even pinned.

Elementary Studies.—The student may now set to work, his paper tightly stretched on the board, his pencils well sharpened. But before beginning to work, it must again be borne in mind that suitable, plain studies are *absolutely necessary* to start with. You *must* master ordinary straight lines and curves before you can safely go ahead with the more interesting sort of drawing. It is hard to make up your mind to this, harder still, perhaps, to carry it out with trouble and perseverance. But a little determination of this kind at the beginning will repay you a thousandfold later on. Moreover, the sooner you can master the simple exercises, the sooner you can safely *and successfully* go on to real self-expression.

Another thing. Make up your mind from the beginning to draw slowly and to take the same pains and trouble about each individual line. Never begin to work before you know exactly what you are going to do. If you find yourself hesitating as to what to do next—stop. If you go on whilst you are uncertain you will only make a muddle of your work, which will display your uncertainty and lack of decision in every line.

If any particular point presents difficulty, you should practice it until the difficulty has passed—even if it is only in so small a matter as the sharpening of your pencils, or, if you find it hard to draw a straight line with your hand in the right position for the purpose, continue to do it until it has become easy. Otherwise, if you allow small matters of difficulty to add themselves up, you will be perpetually hampered.

Control of the Hand.—In the matter of controlling the hand you will find that you must unlearn a good deal. We may take it for granted that before *learning* to draw, you will have done a good deal of drawing by the light of nature; and quite possibly it will have been first-rate drawing too. It is even possible that you have a natural bent for holding your hand in the right manner. But, generally speaking, people do not do this, and they will find, when beginning to learn, that in order to draw correctly they must hold their hands in an altogether new way; and to hold your hand for drawing in a new way needs considerable practice. At first it will be unsteady and will produce a shaky line, so that you must work and work again until every variety of line you make is certain and decisive.

Another very important point to remember is that you should carefully study the object you intend to draw before beginning to draw it. You need to become thoroughly familiar with it, so that you can remember the smallest detail and see a complete picture in your mind's eye. This is not meant to convey that you should draw from memory, but if you know your subject thoroughly in the first instance it will help you towards true perfection and the true placing of details when you come to draw from the actual object in question.

It is extremely important, when drawing, to sit upright with your drawing board immediately in front of you. Some people feel naturally inclined to sit sideways on to their drawing. This is a mistake. The object that you are copying should also be put directly behind your drawing board, so that you can see it by raising your eyes, but without moving, and you should never stoop to your work.

As to the way a pencil should be held, a great authority has said: "A pencil should be so held that if dropped from the hand in the act of drawing the line it would fall on the paper at a right angle with the line."

Now turn to the illustration, and you will see that for the perpendicular line *a–b*, the pencil must be held horizontally (Fig. 1). Fig. 2 gives the position for a horizontal line, and Figs. 3 and 4 for inclined lines. To draw a good, clean straight line like this, needs practice; but it can be done without moving the wrist, without wasting energy; and, moreover, it is the only means of ensuring that the line shall be genuinely straight.

There are two kinds of lines, namely, straight and curved. As the student may easily imagine, it is a curved line which usually presents the greatest difficulty. The straight line is definite, going first from one point to another. The curved line is indefinite in the sense that it goes from one point to another, not by the shortest route, but by a bending route which should be even. It is for this that accuracy of observation should be most carefully trained.

J. G. B. L.

IN THE NATIONAL GALLERY

HOWEVER set the art student's mind may be with determination to conquer the troubles and difficulties of elementary drawing (and if he means to make the smallest success of his artistic career he must steadfastly maintain this resolve), he will necessarily require a certain amount of relaxation, and he will wish to think a little ahead, imagining the time when he can put into practice his own ideas. It is proposed, therefore, to provide a certain amount of discussion of known art at the conclusion of each lesson in the technical and laborious stages.

Nothing so stimulates the beginner as the contemplation from time to time of work which appeals peculiarly to him, work inspired by feelings which the onlooker knows that he has in common with the artist. Such contemplation fires the ambition, and arouses in the heart of the onlooker the determination to do as well or better in the particular sphere of expression he has chosen for himself. This is an emotion quite apart and separated from the sheer delight to

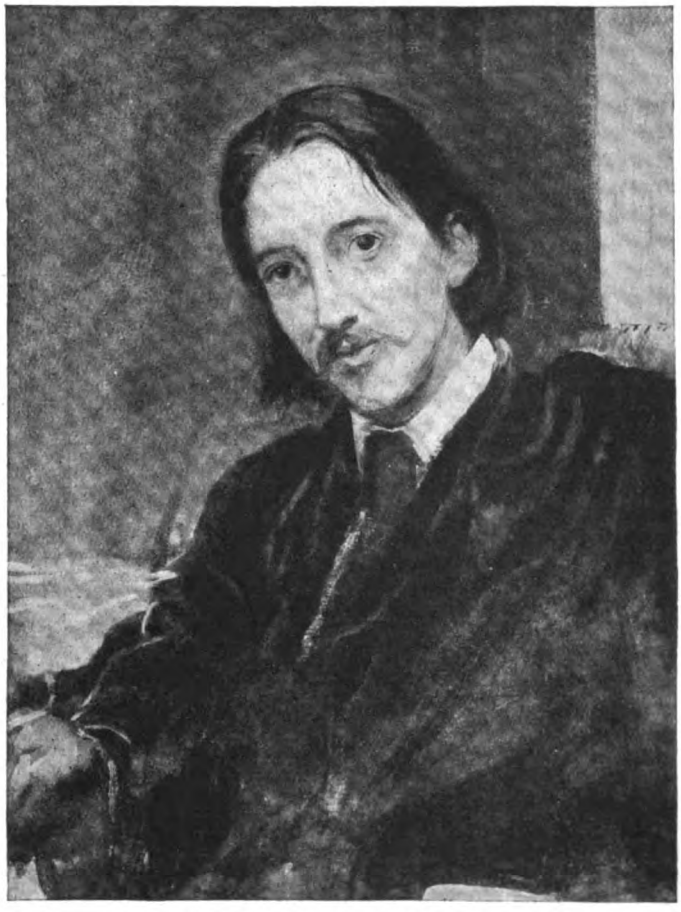
mind and eye that a really good picture evokes.

Very fortunately for us there is no lack of good pictures in this country, particularly in London : and many weeks of sheer delight can well be spent both in the National Gallery and the National Portrait Gallery, to mention two only. These two galleries have been intentionally chosen in the present instance for a reason. The National Gallery is full of pictures of every possible description. The National Portrait Gallery, as its name implies, is full of pictures of only one description. Now, portraits have a peculiar interest, an extrinsic appeal which has nothing whatever to do with art. If you go into the National Portrait Gallery you will see pictures of various people who particularly interest you. There is a portrait, unfinished as a matter of fact, of Robert Louis Stevenson. You are, we will say, devoted to Stevenson's works. What more natural than that you should be particularly happy in knowing that you can see his picture? But it is your interest in Stevenson, not your interest in art, which speaks. So it is that people are often very prone to run away with an exaggerated idea of a picture's merits because the subject interests them.

By this it is not meant that the portrait of Stevenson, unfinished though it is, is in any way a bad picture. But if you see a bad—downright, vilely bad—portrait of a person you are fond of or peculiarly interested in, you think of the person before the picture and so speak of the picture in the terms appropriate to the person. And if you once get into the way of doing this you will gradually learn to acquire a poor estimate of art.

Now turn to the National Gallery. There you have a chance of judging pictures for yourself solely on their own merits. If you do happen to see portraits, they are of people far too remote for the most part from your personal feelings to influence in any way your judgment.

There, too, you can apply the same objective standard of criticism to objects of nature, landscape scenes, paintings of animals, and sea sketches. You will note the degree of perfection attained by the artist in his colour scheme. The mood of nature which he strives to depict can easily be ruined by a dash of the wrong colour, by too bright a sky or too dark a landscape. In this connection you should observe the exquisite and delicate colouring of a clear sunset on a transparent sea by Turner.



PAINTED IN ONE SITTING.

A sketch of R. L. Stevenson by Sir William Blake Richmond, R.A., in the National Portrait Gallery.

Much profit will be gained by observing the composition of the pictures; that is, their structure or drawing. Here again, even if the blend of colour is successful and interprets the precise atmosphere of the scene, a discordant line will have bad effects. An artificial symmetry in construction will also spoil an otherwise good picture. J. G. B. L.

Continued from page 55

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A. [Lond.])

ARITHMETIC.—II

Subtraction

11. To subtract a smaller number from a larger one is to find out what number is left when the smaller is taken from the larger.

The number thus found is called the **Difference. Simple** and **Compound** subtraction are distinguished from one another in the same way as simple and compound addition.

The sign −, **minus,** placed before a number means that the number is to be subtracted.

Thus, $15 - 5 - 2$ means that 5 is to be taken away from 15 and 2 is to be taken away from their difference.

The sign $\overline{\quad}$, **vinculum,** placed over numbers, and the sign ( ), { }, [ ], brackets, enclosing numbers, means that the numbers under the vinculum or enclosed in the brackets are to be treated as a whole.

Thus $15 - (5 + 3)$ means that 5 is to be subtracted from 15 and 3 is to be subtracted from the difference; i.e. $15 - (5 + 3) = 15 - 5 - 3$.

12. To subtract 2 from 9.

On referring to the table in § 9, p. 53, we find that $9 = 7 + 2$, ∴ if 2 be subtracted from 9, the difference is 7.

11	2 & 9	3 & 8	4 & 7	5 & 6
12	3 & 9	4 & 8	5 & 7	6 & 6
13	4 & 9	5 & 8	6 & 7	
14	5 & 9	6 & 8	7 & 7	
15	6 & 9	7 & 8		
16	7 & 9	8 & 8		
17	8 & 9			
18	9 & 9			

This table, constructed on the same principle as the one in § 9, should be proved by the student. Further, he should thoroughly familiarise himself with it before going any farther.

13. Subtract 2548 from 7396.

It is usual to place the smaller number under the larger (units under units, tens under tens, etc.), and draw a line beneath. We have to find what number added to 2548 will make 7396. Suppose we were doing an addition sum: one of the numbers to be added is 2548, the other is unknown, and may be represented by ****, while the sum of the two is 7396. We start as usual on the right. What digit added to 8 makes a total ending in 6? This total might be 16, 26, 36, etc., but we know that the sum of two digits is always less than 20, ∴ this total must be 16. From the tables § 9, § 12 we know 8 and 8 are 16; thus the unknown digit is 8, and we write it down in the units' place and proceed with our addition. 8 and 8 are 16, carry 1; 1 and 4 are 5, and some digit added to 5 makes 9; this is 4 (§ 9), and we write down 4 in the second place and proceed with our addition. 5 and 4 are 9, nothing to carry; some digit added to 5 makes a total ending in 3, and this total must be 13 (see above); 5 and 8 are 13 (§ 12), and we write down 8 in the third place and proceed with our addition. 5 and 8 are 13, carry 1; 1 and 2 are 3, and some digit added to 3 makes 7, and this digit is 4 (§ 9), and we write down 4 in the last place, having found the unknown number.

```
 7396      ****
 2548      2548
 ----      ----
 ****      7396

 7396      ***8
 2548      2548
 ----      ----
 ***8      7396

 7396      **48
 2548      2548
 ----      ----
 **48      7396

 7396      *848
 2548      2548
 ----      ----
 *848      7396

 7396      4848
 2548      2548
 ----      ----
 4848      7396
```

Arranging this in the usual way we may write thus:

7396	7396	7396	7396	7396
2548	2548	2548	2548	2548
----	----	----	----	----
****	***8	**48	*848	4848

All that is actually necessary is the last of these, and all the student need say to himself after a little practice is:

8 and **8,** 5 and **4,** 5 and **8,** 3 and **4,** writing each new figure 8, 4, 8, 4 as he says it, from right to left.

Exercise 4

(1) Perform the following subtractions:

(*a*)	(*b*)	(*c*)	(*d*)	(*e*)	(*f*)
27	145	905	594301	1000010	1000000
13	101	876	489728	998989	100100

(2) Find the difference between:

(*a*) 65,748,912 and 49,785,643.
(*b*) 582,100,900 and 25,763,981.
(*c*) 123,456,789 and 99,999,999.
(*d*) 987,654,321 and 123,456,789.

(3) How much greater is:

229,750,103 than 22,975,010 ?
7,984,605,134 „ 2,897,858,466 ?
10,001,001,001 „ 1,000,100,100 ?

Exercise 5

(1) If A owes B £594, B owes C £355, C owes D £495, and D owes A £517, how can they most easily settle accounts ?

(2) A child was born when his father was 31; the father was born when the grandfather was 25. How old will the grandfather be when the child is 18 ?

(3) In a college 115 men speak French, 78 speak German, and 24 speak both French and German. How many men were there altogether ?

(4) In a town there were 27,000 inhabitants; 8943 were men, 9318 were women, and the rest were children. How many children were there ?

Multiplication

14. Multiplication is the method of finding the sum of numbers which are all equal. To multiply one given number, called the **multiplicand,** by another given number, called the **multiplier,** is to add the multiplicand to itself as many times as there are units in the multiplier. Thus, to multiply 3 by 4 is to add 3 to itself 4 times, and the sum thus obtained is $3 + 3 + 3 + 3 = 12$.

The result of multiplying one number by another is called the **product;** the multiplier and multiplicand are called **factors** of the product, and the product a **multiple** of either of its factors.

The sign $\times$, **multiplied by,** placed before a number, means that that number is a multiplier.

When brackets occur the sign of multiplication is often omitted: $(2 + 3) \times 4$ is often written $(2 + 3)\ 4 = 5 \times 4 = 20$; and $(2 + 3)\ (4 + 5) = 5 \times 9 = 45$.

Multiplication is called **simple** when the multiplicand is an abstract number or a concrete number of one denomination. It is called **compound** when the multiplicand contains concrete numbers of more than one denomination. Thus 2×3 and £2 $\times$ 3 are examples of simple multiplication; whereas £2 17s. 6d. $\times$ 3 is an example of compound multiplication. The multiplier must always be abstract; if 2 people each have 3 shillings, they have together 3 shillings $\times$ 2 = 6 shillings. We cannot multiply 3 shillings by 2 people but we can multiply 3 shillings by the abstract number 2.

15. Elementary multiplications must be performed by addition. The student should make for himself, and learn by heart, the table shown on this page, by means of which all subsequent multiplications can be performed.

Every horizontal line in the table gives the products obtained by multiplying the first number on the left of the line by successive numbers from 1 to 12.

Thus, the fifth line may be read, 1 five is 5, 2 fives are 10, 3 fives are 15, 4 fives are 20, etc.

16. When one number is multiplied by two or more other numbers, the result is called a **continued product.**

Thus $2 \times 3 \times 4 = 24$. Here 24 is the continued product of 2, 3, and 4.

17. (*a*) **The product of any number by any second number is the same as the product of the second number by the first.**

(*b*) **The product of any two numbers is the same as the sum of the products of the multiplier and any two or more numbers which together make up the multiplicand.**

(*c*) **The product of any two numbers is the same as the sum of the products of the multiplicand and any two or more numbers which together make up the multiplier.**

MULTIPLICATION TABLE

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

18. Now consider the following arrangement. Here the sum of all the numbers consists of 4 repeated 7×3 times, that is, 4×21. But in each row 4 is repeated 7 times, and each row is repeated 3 times; hence the sum of all the numbers is $4 \times 7 \times 3$. Again, in each column 4 is repeated 3 times, and each column is repeated 7 times; hence the sum of all the numbers is $4 \times 3 \times 7$. Hence, to multiply by 3 and 7 in any order is the same as multiplying at once by 3×7, i.e. by 21. The same thing obviously holds good for any other numbers whatever.

4 4 4 4 4 4 4
4 4 4 4 4 4 4
4 4 4 4 4 4 4

Hence, **to multiply by two or more numbers in succession gives the same result as multiplying by their product.**

19. To multiply by 10, 100, etc.—To multiply any number by 10 is the same as multiplying each of its parts by 10, § 17 (*b*). Numbers consist of units, tens, hundreds, etc., and if we put

a cipher on the right of any number expressed in figures, each figure is shifted one place to the left; i.e. the units become tens, the tens become hundreds, etc., so that each part is multiplied by 10 and ∴ the whole number is multiplied by 10.

Hence, **any number expressed in figures is multiplied by 10, by placing a nought on the right of it.**

20. Example of multiplication:

Multiply 459 by 7. By § 17 (*b*) this is the same as multiplying 4 hundreds 5 tens and 9 units by 7 and adding the results. 4 hundreds × 7 = 28 hundreds = 2 thousands and 8 hundreds; 5 tens × 7 = 35 tens = 3 hundreds and 5 tens; 9 units × 7 = 63 units = 6 tens and 3 units.

459
7
2800
350
63
3213

This result is in practice obtained in one line. We write the multiplier below the multiplicand, draw a line beneath, and proceed thus, starting with the units: 9 units taken 7 times is 63 units, i.e. 3 units and 6 tens, ∴ put 3 in the units' place and carry 6; 5 tens taken 7 times is 35 tens, to which must be added the 6 tens that were carried, and we obtain 41 tens, i.e. 1 ten and 4 hundreds, ∴ put 1 in the tens' place and carry 4; 4 hundreds taken 7 times is 28 hundreds; to this must be added the 4 hundreds, and we obtain 32 hundreds, i.e. 2 hundreds and 3 thousands, ∴ put 2 in the hundreds' place and 3 in the thousands' place. In actually doing this multiplication the student would say: 7 nines are **63**, 7 fives are 35 and 6 are **41**, 7 fours are 28 and 4 are **32**, and he would put down in order from right to left the figures in blacker type, i.e. 3, 1, 2, 3.

459
7
3213

21. The product of a number multiplied by itself is called the **square** of that number. Thus, $3 \times 3 = 9$, 9 is the square of 3 and is written 3^2.

If a number be taken 3 times as a factor, the result is called the **cube** of that number. Thus $3 \times 3 \times 3 = 9 \times 3 = 27$, 27 is called the cube of 3 and is written 3^3.

If a number be taken 4 times as a factor, the result is called the **4th power** of the number; if it be taken 5 times as a factor we get the **5th power,** and so on.

The small figure written at the top right-hand of the number is called the **index** or **exponent.**

22. When the multiplier can be resolved into factors, it is more convenient to find the continued product of the multiplicand and the factors of the multiplier than to perform the multiplication straight away.

Exercise 6

(1) 29 × 4. (2) 31 × 7. (3) 493 × 9. (4) 2768 × 13. (5) 35948 × 12. (6) 794285 × 29. (7) 4285 × 233. (8) 67014 × 592. (9) 987641 × 7143. (10) 987104 × 146873. (11) 11072685 × 237916. (12) Find the product of (*a*) 2,893,432 × 72,894,615; (*b*) 52,471,213 × 11,604,208; (*c*) 213,110,217 × 53,947,412. (13) Find the continued product of (*a*) 39, 41, 43, 57, and 67; (*b*) 387, 493, 5,784, 3,003, and 15,555.

M. A. L.

ALGEBRA.—II

12 (*continued*). — **Brackets** are of various shapes: round ( ), curly { }, and square [ ]. Instead of brackets a line drawn over the expression may be used; this line is called a **vinculum.** Thus $\overline{a+b}$ is the same as $(a+b)$; $a+\overline{b-c}$ is the same as $a+(b-c)$. The vinculum is always used with the radical sign if that sign is to apply to more than the figure or letter which immediately follows it. Thus $\sqrt{a}.b$ means that the square root of a is to be multiplied by b, but $\sqrt{ab}$ means that the product of a and b is to be found, and then the square root of that taken. Similarly $\sqrt{a}+x$ means that x is to be added to the square root of a, whereas $\sqrt{a+x}$ means that the square root of the sum of a and x is to be found.

The line between the numerator and denominator of a fraction acts as a vinculum. Thus $\frac{a}{b+c}$ means that a is to be divided by the sum of b and c.

13. It is most important to note that every term of an algebraic expression must be added and subtracted as a whole. In other words, multiplication and division must be performed before addition and subtraction. This is clear from the following:

$3a + b \times (c + d) - 2k + l \div m$ may be written $3a + b(c + d) - 2k + \frac{l}{m}$. That is, $b \times (c+d)$ forms one term and $l \div m$ forms one term.

The expression means that the product of b and $(c + d)$ is to be added to $3a$, that $2k$ is to be subtracted from this sum, and that the quotient of l by m is to be added to the difference.

14. If we are considering a quantity of any kind, then $+a$ will stand for something which increases that quantity by a units. On the other hand, $-a$ will stand for something which decreases that quantity by a units.

Let us suppose that a person has engaged in some business transactions, and that he owes some people money, while others owe him money. Supposing the sums he owes are £a, £b, and £c, while the sums due to him are £d, £e, £f, and £g.

If we wish to estimate his profits we should put down the sums due to him as + £d + £e + £f + £g, since these increase his profits. On the other hand, we should put down the sums he owes as − £a − £b − £c, since these decrease his profits.

His total profit may then be represented by + £d + £e + £f + £g − £a − £b − £c.

If, however, we wish to estimate his losses we should put down the sums he owes as + £a + £b + £c, since these increase his losses, and we should put down the sums due to him as − £d − £e − £f − £g, since these decrease his losses.

His total losses may then be represented by + £a + £b + £c − £d − £e − £f − £g.

15. From the foregoing we see that the **signs + and − may be used not only as symbols of operation, but also to distinguish between quantities of directly opposite kinds.** That is to say, if we consider profits, + £a represents a profit of a pounds, and − £a

represents a debt or loss of a pounds, i.e. a quantity of a kind directly opposite to $+ £a$.

Whether we prefix the sign + or − depends on our point of view; for if we are considering losses, then $+ £a$ represents a loss of a pounds, whereas $- £a$ represents a gain of a pounds.

16. A quantity to which the sign + is attached is called a **positive** quantity.

A quantity to which the sign − is attached is called a **negative** quantity.

The signs + and − are called respectively the **positive sign** and **negative sign.**

When we speak of **the sign** of a quantity we refer to the + or − prefixed to it.

When we speak of **changing the signs** of an expression we mean that we change the + or − prefixed to each term into − or + respectively.

A quantity without any sign prefixed to it is **positive.** The positive sign is very often omitted before the first term of an expression.

The magnitude of a quantity considered independently of its sign is called its **absolute magnitude.**

Thus, a is the absolute magnitude of both $+a$ and $-a$.

17. Let us return to our illustration of a man who owes certain sums, and to whom other sums are due.

Suppose A engages an agent B to collect the sums due to him and pay the sums he owes. Let us further suppose that B has a certain amount of ready cash, so that if it suits him he can pay some of A's creditors before he collects any sums due to A.

Then, if $+a$ represents a pounds to be paid by some debtor to A, and $-b$ represents b pounds which A has to pay to some creditor, then $+a-b+c+d-e-f$ will represent the following transactions on the part of B: $£a$ collected, $£b$ paid out, $£c$ collected, $£d$ collected, $£e$ paid out, $£f$ paid out.

Now it is clear that the final result of the transactions will be the same, whatever the order of collecting and paying may be.

18. Suppose two separate individuals each owe A £1. These two debts to A are equivalent to one debt of £2; we may **associate** these, which we express as $+1+1$, into $+(+1+1)$, denoting by the bracket that the two debts are regarded as one, and indicating by the + sign before the bracket that the money is "due to A."

Hence $+1+1=+(+1+1)=+2$.

Similarly $+a+b=+(+a+b)$.

Now let us suppose that A's agent B collects altogether $£a$ due to A and pays out for A $£b$ and $£c$. If we associate these sums, the result from A's point of view is $+(+a-b-c)$. Now if we look at the result from B's point of view, we see that he owes A $£a$ and that A owes him $£b$ and $£c$, that the result from B's point of view is $+(-a+b+c)$, which A owes him. Once more taking A's point of view, we may express this as $-(-a+b+c)$, where the − sign outside the bracket means "owed by A."

If we combine these two results with our original way of indicating sums owing, and sums due (§ 17), we have

$$+a-b-c=+(+a-b-c).$$
$$+a-b-c=-(-a+b+c).$$

Hence **an algebraic sum associated into a single operation by means of a bracket** may be dissociated into the component additions and subtractions by removing the bracket and retaining all the signs unchanged if the bracket be preceded by a + sign, and changing all the signs if the bracket be preceded by a − sign; and conversely.

The above is called the **Law of Association for addition and subtraction.**

19. Let us for a moment consider actual sums in connection with the above. Suppose B collects £20 and pays out £7 and £5. Then we have

$$+£20-£7-£5=+(+£20-£7-£5)=+£8.$$
$$+£20-£7-£5=-(-£20+£7+£5)=+£8.$$

That is, the result is a profit of £8 for A.

Again, suppose B collects £5 and pays out £3 and £4.

Then

$$+£5-£3-£4=+(+£5-£3-£4)=-£2.$$
$$+£5-£3-£4=-(-£5+£3+£4)=-£2.$$

That is, the result is a loss of £2 for A, which he owes to B.

20. If we consider only one term in the bracket and apply the Law of Association, we get the following:

$$+(+a)=+a. \qquad +(-a)=-a.$$
$$-(+a)=-a. \qquad -(-a)=+a.$$

From which we conclude that **two like signs give rise to a + sign, and two unlike signs give rise to a − sign.**

Thus we see that dissociation consists of two parts: (1) the removal of the bracket (or brackets); (2) the determination of the sign of each term.
$-(-a+b+c)=-(-a)-(+b)-(+c)=+a-b-c$

There may, of course, be a cumulation of the signs + and −:

$$+a=+(+a)=+(+(+a))=+(+(-(-a)))$$
$$=+(+(+(-(-a)))), \text{ and so on;}$$

and—

$$-a=-(+a)=+(-a)=-(+(+a))$$
$$=+(-(-(-a))), \text{ and so on.}$$

21. As regards algebraic quantities, there is a convention to the effect that an algebraic quantity a is greater or less than an algebraic quantity b, according as the algebraic sum $a-b$ is positive or negative.

Supposing a be any positive algebraic quantity, say $+\alpha$, and supposing b be any negative algebraic quantity, say $-\beta$.

Then $a-b=+\alpha-(-\beta)=+\alpha+\beta$, which is obviously positive, however small α may be. Hence we see that any positive algebraic quantity, however small, is greater than any negative algebraic quantity.

Thus $+1>-10$
for $(+1)-(-10)=+1+10=+11$.

Supposing a be any negative algebraic quantity, say $-\alpha$; and b be any negative algebraic

quantity, say $-\beta$, then by the above a is greater or less than b according as β is greater or less than a.

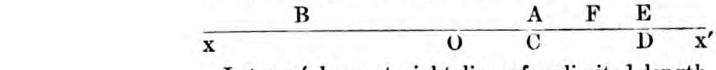
For $a - b = -a - (-\beta) = -a + \beta$, and this is positive if $\beta > a$, but is negative if $\beta < a$.

Thus $-7 > -12$
for $(-7) - (-12) = -7 + 12 = +5$.

If we use ∞ to denote a quantity greater than any assignable quantity, we have an infinite series of algebraic quantity, viz.:
$-\infty, -\ldots, -3, -2, -1, \pm 0, +1, +2, +\ldots, +\infty$,
in ascending order of magnitude from left to right.

Since $-0 = +0$, we may look on 0 as belonging to the negative and the positive parts of the series, and this is indicated by the double sign $\pm$.

22. There is another mode of denoting positive and negative quantities which is much used in many branches of mathematics and which furnishes an illustration even clearer.



Let x x′ be a straight line of unlimited length. We shall reckon any step to the **right** as being **positive,** and any step to the **left** as being **negative.**

Thus, the step O A is positive and the step A O is negative.

The step O B is negative and the step B O is positive.

The resultant obtained by compounding two or more steps, O A, C D, E F, is obtained by placing the steps, without changing their direction, so that C coincides with A and E coincides with D, as in the figure. This resultant is the step O F.

If the student draws figures for himself, he will see that the following statements are true.

I. **The resultant of any number of steps is independent of the order in which they are compounded.**

Thus, the resultant of O A, C D, E F is the same as the resultant of C D, O A, E F, or of E F, O A, C D, and so on.

II. **The resultant of two or more positive steps** is a positive step whose length equals the sum of the lengths of the components.

III. **The resultant of two or more negative steps** is a negative step whose length equals the sum of the lengths of the components.

IV. **The resultant of a positive step and a negative step** is a step whose length equals the difference of the lengths of the components, and whose direction is positive or negative according as the length of the positive or the negative component is greater.

V. **The resultant of any number of positive and negative steps** is a step whose length equals the difference between the sum of the lengths of the positive components and the sum of the lengths of the negative components, and whose direction is positive or negative, according as the former sum or the latter sum is the greater.

Now if any step to the right contains a units of length, we may denote it by $+a$, and if a step to the left contains a units of length, we may denote it by $-a$.

23. If we take a definite point O on the straight line of unlimited length x x′, and use that as a point of reference, then the point O is called the **origin.**

Positive quantities may be represented by steps to the right of O, and negative quantities by steps to the left of O.

In a representation of this kind, to every algebraic quantity one and only one point on the straight line x x′ will correspond.

The point O will correspond to 0, and the series of algebraic quantities

$$-\infty, -\ldots, -2, -1{\cdot}5, -1{\cdot}25,$$
$$-1, -{\cdot}5, -{\cdot}25, 0, +{\cdot}25, +{\cdot}5,$$
$$+1, +1{\cdot}25, +2, +3, +\ldots, +\infty$$

will correspond to an infinite series of points from left to right on the straight line of unlimited length x O x′.

The step to the right or left of O to a point P, or the corresponding algebraic quantity, is called **the co-ordinate of the point P with respect to the origin O.**

Exercise 2

(1) Find the algebraic sum of the following:
(*a*) $7 - 6$; (*b*) $-7 + 6$; (*c*) $9 + 8 - 5$; (*d*) $9 - 8 - 5$; (*e*) $-9 - 8 + 5$; (*f*) $-9 + 8 - 5$; (*g*) $-9 - 8 - 5$.

Simplify the following by removing the brackets:
(2) $(2 + 4 + 6) - (2 - 4 + 6) - (2 + 4 - 6) + (-2 + 4 - 6)$.
(3) $(7 + 1 - 9) - (7 + 1 + 9 - 13 + 2) - (2 - 8 + 3)$.
(4) Which is the greater, $2 - (4 - 7)$ or $3 - (5 + 1)$?
(5) A snail is on a wall 2 feet from the ground; it crawls up 6 inches, slips down 11·5 inches, and crawls up 3 inches. How much higher is it in this position than when it started?
(6) The following steps on a straight line are made from the origin O, -6, $+3$, $+5$, -4. What is the co-ordinate of the point reached?

Key to Exercise 1

(1) 22. (2) 0. (3) 22. (4) 20. (5) 6. (6) 3. (7) 1. (8) 42. (9) 55. (10) 172. (11) 19. (12) 38. (13) $\frac{3}{4}$. (14) 62. (15) $75\frac{3}{4}$. (16) $59\frac{1}{2}\frac{1}{5}$.

M. A. L.

GEOMETRY.—I

1. The object of Geometry is to study and measure the shapes and sizes of some of the more simple and regularly shaped things amongst the many bodies in the universe.

2. The student should examine some of the solids illustrated below, and note the following points:—

(1) A cube has 8 corners, all square; it has 12 edges, and these are all straight and equal in length; it has 6 faces and they are all flat. (Fig. 1.)

(2) A rectangular block also has 8 corners all

square; it has 12 straight edges, but they are *not* all equal; and it has 6 faces all flat. (Fig. 2.)

(3) A wedge has 6 corners, 9 straight edges, and 5 faces. The flat ends are triangles. (Fig. 3.)

(4) A sphere has no corners or edges, and its face is curved. If a slice be cut off, each piece has a curved edge and consists of 2 faces, one curved and one flat. This latter is a circle. (Fig. 4.)

(5) A cylinder has no corners; 2 curved edges; 3 faces, one of them curved, and the 2 end ones, which are flat, are circles. (Fig. 5.)

3. If now we consider solid bodies, we find that they have one quality in common, and that is that they occupy space.

The boundary which separates a solid body from the space round it is called a **surface.** If two surfaces intersect (cut one another) the place where they intersect is called a **line.**

Figure 6 shows the intersection of two flat surfaces. Figure 7 that of the surface of a sphere and the surface of a saucer shaped body.

If two lines intersect, the place where they cut is called a **point.**

4. It is clear, if we examine a **solid body,** say a box, that it has three dimensions, namely: length, breadth and thickness.

A **surface** is the boundary of a portion of space (i.e. the portion occupied by a solid body); it has two dimensions, namely: length and breadth.

A **line,** which is the intersection of two surfaces, has one dimension only, namely: length.

A **point,** which is the intersection of two lines, has neither length, breadth nor thickness; i.e. it has no dimensions. It merely marks a position.

5. The student must realise that geometrical surfaces, lines and points are ideal things and cannot be actually represented.

6. Lines are either straight or curved.

A **straight line** may be defined as the shortest distance between two points.

7. Two straight lines are said to be **equal** if the one can be fitted exactly on to the other, so that they begin at the same point and end at the same point. In other words, two straight lines are equal if they can be made to coincide.

8. A **plane** or a **plane surface** is such that if any two points on the surface be joined by a straight line, that straight line lies entirely on the surface.

To test whether a surface be plane, apply the edge of a flat ruler to it. If there is any space between the surface and the ruler, then the former is not plane but curved.

Figs. 8 and 9 illustrate curved surfaces.

A **figure** is a collection of lines, points and surfaces, and any figure which lies wholly in one plane is called a plane figure.

9. Let a straight line rotate in a plane about the point O. Let it start from the position O A and turn till it reaches the position O B. Then the amount of turning which the line has done to reach the position O B is called **an angle.** It is called the angle between O A and O B, or the angle A O B. (Fig. 10.)

O A, O B are called the **arms of the angle,** and O is called its **vertex.**

The student will note that the position O B may be reached in two ways. Either by rotating counter-clockwise as in Fig. 10, or by rotating clockwise as in Fig. 11. Clearly the amount of turning done in the two cases is not the same. Thus the lines O A, O B may be said to contain two angles, but these are not necessarily equal. As a rule when we speak of the angle A O B, we mean the smaller angle.

Note that the size of an angle is in no way affected by the length of the arms, but only by their direction.

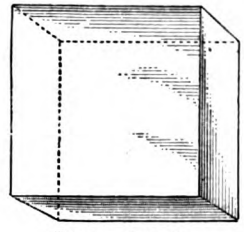


Fig. 1.—A Cube.

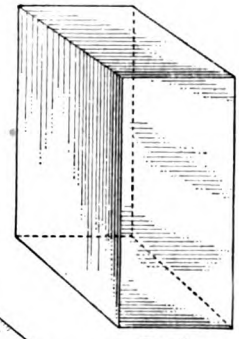


Fig. 2.—Rectangular Block.

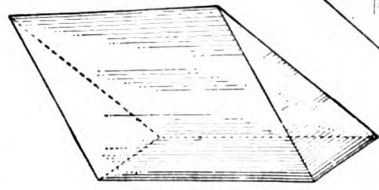


Fig. 3.—A Wedge.

Fig. 4.—A Sphere.

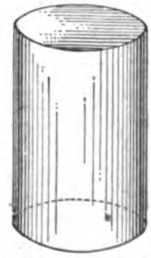


Fig. 5.—A Cylinder.

10. Angles are equal when each is produced by the same amount of turning.

To test the equality of two angles A B O and P Q R. Make a copy P′ Q′ R′ of one of them, say, P Q R. Place P′ Q′ R′ so that Q′ coincides with B and Q′ R′ lies along B O. Then if Q′ P′ lies along B A the angles are equal. (Fig. 12.)

11. If we take a piece of paper with a straight edge A O B, and fold it (Fig. 15) so that O A lies on O B, we shall get a crease O P in the middle, and clearly the angle A O P will be equal to the angle B O P since the two coincide with one another. If then we flatten the paper again we have a straight line P O meeting a straight line A B at O and making the adjacent angles A O P, B O P equal to one another. These two angles are called right angles. Hence we get the following definition. If one straight line meeting another straight line make the adjacent angles equal to one another, the angles are **right angles** and the straight lines are said to be **perpendicular** to one another.

12. Consider a line O A, and let it revolve counter-

clockwise round the point O through the positions O B, O C, O D . . . O H until it comes back to the position O A. It will then have made one **complete revolution.** (Fig. 14.)

When it is in the position O E, the arrow head points exactly in the opposite direction to that in which it points in O A. The line O A will have made **half a revolution,** for if we fold the paper along the line A O E we find the angle described in passing from O A to O E exactly fits the angle described in passing from O E to O A. That is, the two angles are equal, and either of them equals half the sum of both. Since both the angles together make one complete revolution, each one of them equals half a revolution.

Again, when O A is in the position O C, the angle A O C is a right angle and by definition equals the angle C O E. Therefore each of the angles A O C, C O E equals half of half a revolution. That is, one right angle equals quarter of a revolution, and therefore one complete revolution equals four right angles.

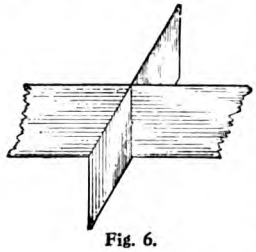


Fig. 6.

If a right angle be divided into 90 equal parts, each part is called a **degree.**

Therefore a complete revolution equals 360 degrees, or as it is usually written, 360°.

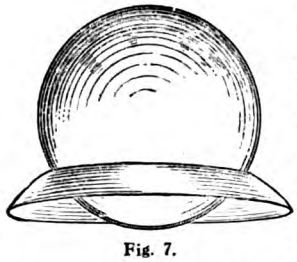


Fig. 7.

The sixtieth part of a degree is called a **minute,** 1′, and the sixtieth part of a minute is called a **second,** 1″.

13. An angle greater than a right angle is called an **obtuse angle.**

An angle less than a right angle is called an **acute angle.**

14. A **circle** is a plane figure bounded by one curved line called the **circumference,** and is such that all straight lines (called **radii**) drawn from a fixed point within (called the **centre**) to the circumference are equal. (Fig. 13.)

A **diameter** of a circle is any straight line drawn through the centre and terminated at both ends by the circumference.

15. A **rectilineal** figure is one which is bounded by straight lines.

16. A **triangle** is a plane figure bounded by three straight lines.

An **equilateral triangle** is one whose three sides are equal.

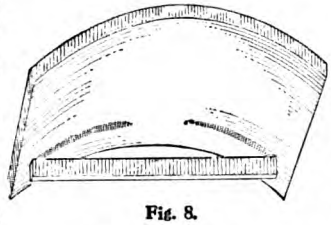


Fig. 8.

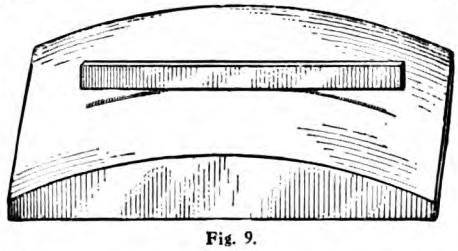


Fig. 9.

An **isosceles triangle** is one which has two equal sides.

A **scalene triangle** is one which has three unequal sides.

A **right angled triangle** is one which has one of its angles a right angle.

The side opposite the right angle is called the **hypotenuse.**

An **obtuse angled triangle** is one which has one of its angles greater than a right angle.

An **acute angled triangle** is one which has each of its angles less than a right angle.

17. A **quadrilateral** is a plane figure bounded by four straight lines. The straight line joining opposite angular points of a quadrilateral is called a **diagonal.**

18. A **polygon** is a plane figure bounded by more than four straight lines.

The student should learn by heart the following:

Postulates (Demands)

(1) A straight line can be drawn from any one point to any other.

(2) A finite straight line (i.e. one that is terminated at both ends) can be produced at either end to any distance.

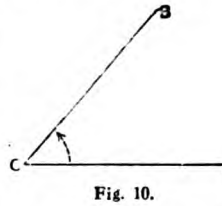


Fig. 10.

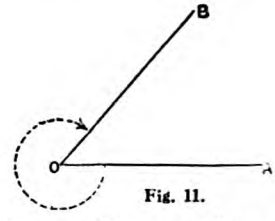


Fig. 11.

(3) A circle can be drawn with any point as centre and with any radius.

These postulates amount to a demand for a long ruler and a pair of compasses with legs long enough to describe a circle of any desired radius.

Axioms (Self-evident truths)

(1) Things which are equal to the same thing are equal to one another.

(2) If equals be added to equals the sums are equal.

(3) If equals be taken from equals the differences are equal.

(4) If equals be added to unequals the sums are unequal.

(5) If equals be taken from unequals the differences are unequal.

(6) Things which are double of the same thing or of equal things are equal to one another.

(7) Things which are halves of the same thing or of equal things are equal to one another.

(8) Magnitudes which can be made to coincide with one another are equal.

(9) The whole is greater than its part.

(10) Two straight lines cannot enclose a space.

The **Propositions** which follow, are divided into **Theorems** and **Problems.** In the former some statement is required to be proved, in the latter something is required to be done.

The statement of what is to be proved or done is called the **Enunciation.**

The enunciation with regard to some particular figure or figures is called the **Particular Enunciation.**

The enunciation of a **Theorem** usually consists of two parts: (1) the **Hypothesis** is that which is assumed to be true, (2) the **Conclusion** is that which has to be proved.

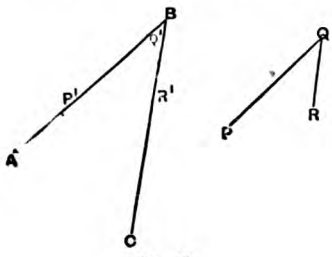


Fig. 12.

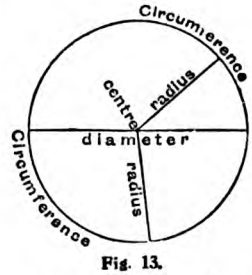


Fig. 13.

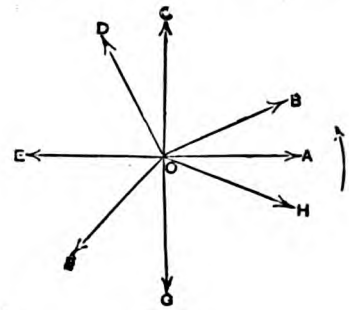


Fig. 14.

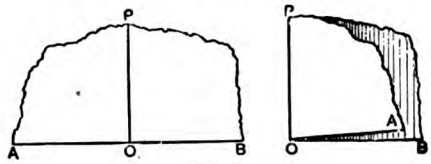


Fig. 15.

The **Converse** of a theorem is one in which the hypothesis and the conclusion are interchanged.

Thus we have the theorem

if two sides of triangle are equal,
hypothesis

then

the angles opposite them are equal,
conclusion

The converse is:

If two angles of a triangle are equal,
hypothesis

then

the sides opposite them are equal.
conclusion

When a **Problem** has been done, it is necessary to prove geometrically that it has been correctly done.

List of Symbols Used

+ plus or " together with "	∴ therefore
− minus or " diminished by "	∠ angle
= equals or " are equal to "	△ triangle
≡ equals in all respects	□ parallelogram
> is greater than	⊙ circle
< is less than	∥ parallel
∵ because	⊥ perpendicular

Abbreviations

rt.	right	ext.	exterior
str.	straight	adj.	adjacent
sq.	square	alt.	alternate
rectil.	rectilineal	isos.	isosceles
rect.	rectangle	equilat.	equilateral
opp.	opposite	diag.	diagonal
int.	interior	diam.	diameter
		pt.	point.

Greek Letters Used to Denote Angles

α Alpha	equivalent to a	λ Lambda	equivalent to l
β Beta	,, ,, b	μ Mew	,, ,, m
γ Gamma	,, ,, c	ν New	,, ,, n
δ Delta	,, ,, d	π Pi	,, ,, p
θ Theta	,, ,, th	ρ Ro	,, ,, r
φ Phi	,, ,, f	σ Sigma	,, ,, s

In learning theorems it is a fatal mistake to commit to memory the steps which lead logically to the conclusion. The first essential in geometry is to *understand.* Each step in the proof always inevitably follows the last and can be deduced logically. To prove to yourself that you thoroughly understand the propositions, you should write them out for yourself, using different letters from those used here. For instance, if you have two triangles lettered A B C and D E F you should re-letter them, say, G H I and L M N.

If the propositions are learnt in a parrot-like fashion, you will never be able to solve problems for yourself or make practical use of geometry.

Exercise 1

(1) Make rectilineal figures of : (*a*) 3 sides (a triangle), (*b*) 4 sides (a quadrilateral), (*c*) 5 sides (a pentagon), (*d*) 6 sides (a hexagon).

(2) Make a figure bounded by (*a*) one curved line, (*b*) 2 curved lines, (*c*) 3 curved lines.

(3) How many degrees does the minute hand of a clock turn through in an hour, quarter of an hour, half an hour, 40 minutes ?

(4) How many degrees does the hour hand of a clock turn through in 1 hour, in 3 hours, in 5½ hours ?

(5) Draw an angle of 60° and an angle of 120°. Cut them out, fit them together and see that two of the bounding edges form a straight line. Do the same with angles of 35° and 145° and also with angles of 20° and 160°.

(6) Draw a circle with a radius of 2 inches.

(7) Draw any angle, cut it out and bisect it (divide it into 2 equal parts) by folding it.

(8) Draw any triangle A B C. Produce A B to any point D. Measure the angles C B D and C A D. Which is greater ?

(9) Make a triangle A B C with A B equal to A C.

(10) Make a triangle A B C with A C equal to B C. Produce A C to D making C D equal to A C. Join B D and measure the angle A B D.

M. A. L.

Continued from page 64.

BUSINESS AND COMMERCE:

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—II

ORGANISATION is of the utmost importance in every modern office. Not only must the work be performed efficiently and speedily, but it must also be carried through economically. Whilst a meeting of the Board of Directors is in progress, for example, the secretary should be able at a moment's notice to obtain from any worker complete details of the particular branch of the business in which he, the worker, is engaged.

This can only be done where each individual unit is responsible for one particular task or series of tasks. Thus, the actual routine of an office must be skilfully apportioned out so that every worker clearly understands the particular duty upon which he or she is engaged, and is responsible for that duty to an immediate superior. It is only when this plan is carried into complete execution that every clerk acquires the knowledge that he has one task, one set of labours for which he is solely to be praised or blamed ; and from this knowledge springs that sense of duty which inspires a man or girl to do the best at the moment for their immediate work, mainly for the sake of that work and partly with a view to promotion.

The Letter Book

One of the first duties of the junior clerk is the care of the letter book, a record that will be found in most departments of every office. The use of this book is to take clean, legible, permanent copies of letters and documents for future reference, and letter books are invariably admitted as evidence in courts of law when litigation takes place. For this reason, no single page should ever be removed, as a case might fail entirely through the judge observing a break in the sequence of the folio numbers. Thus, where through unavoidable mischance a page is spoiled a diagonal cross from corner to corner should be neatly ruled.

Generally, a letter book consists of 100, 200 or 250 pages of a toughened tissue paper, each page numbered consecutively on the front side only. The tissue pages follow a ruled index, which is invariably interleaved with blotting, and it is the junior's duty not only to press-copy the letters given him, but also to keep the index up to date from day to day. Old letter books are usually boldly numbered with a paste-on tab and put away in cupboards, and the responsible lad, as soon as he sees he is approaching the end of one book, should make a point of acquainting his superior or the stationery clerk, so that another book may be ordered.

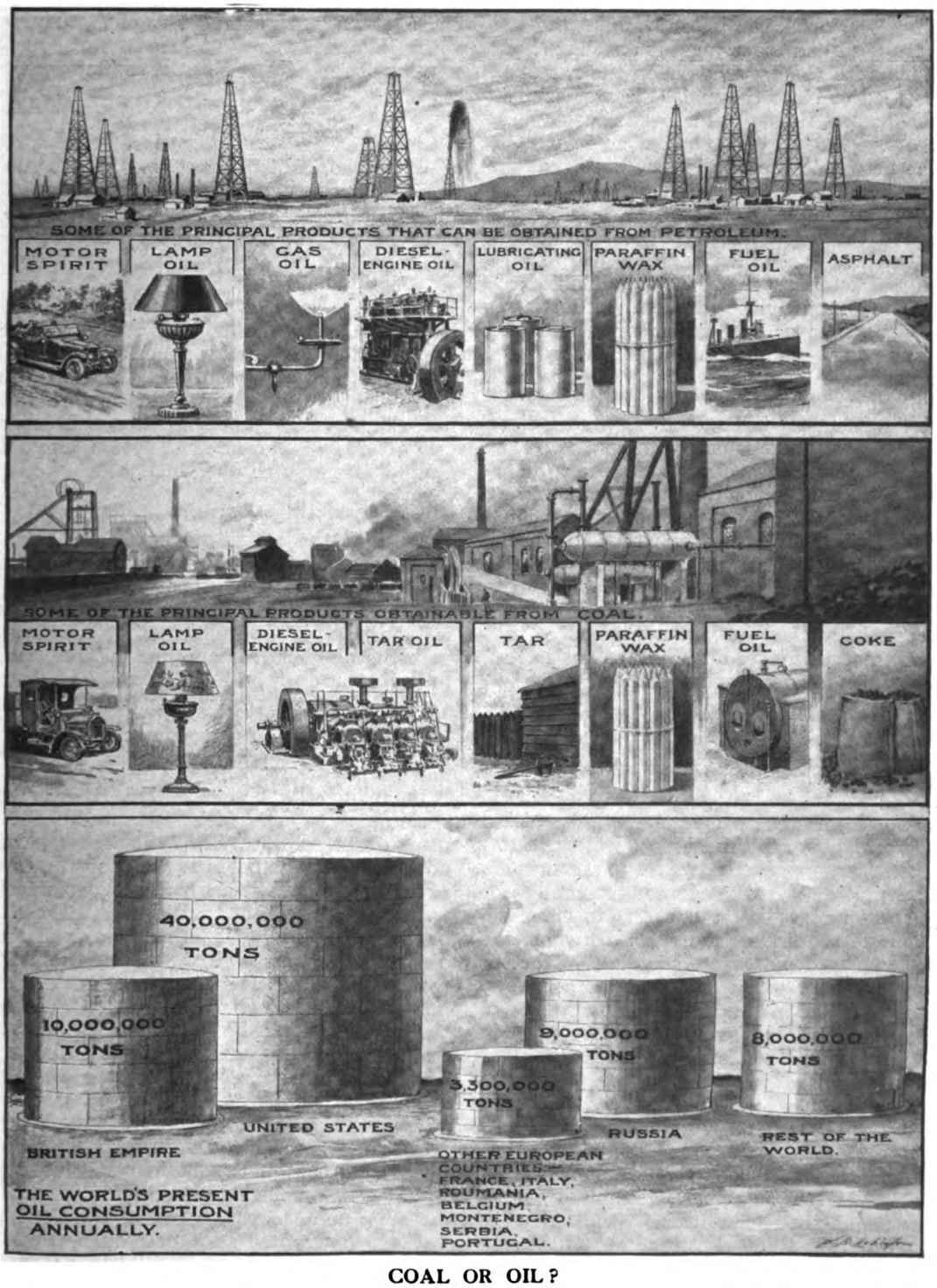
Copying Letters

The actual system of press-copying letters varies slightly in different offices, though the general principles are the same. The letters or documents to be copied are typed or written from a copying ribbon or pad, or with copying ink, and when this ink is employed it must not be dried with blotting paper or fair copies will not be obtainable. To obtain a copy one must dampen a sheet in the letter book, or a loose sheet of copying paper as the case may be, place the document to be copied under this and insert them in the copying-press.

Judge the exact degree of dampness required : too much moisture gives a smudgy and often illegible copy, besides spoiling the original ; too little moisture can only result in a faint copy. Experiment on loose copying paper until you become proficient.

In some offices the rule is to dampen the sheets with a wide, flat brush fitting into a receptacle for water ; in other offices linen sheets are used, these being dipped in water and then wrung to a sufficient degree of dryness. The linen sheets are the more satisfactory with typewritten documents.

Oiled sheets are used with a letter book to give protection to the pages already filled, and an absorbent sheet is employed to remove superfluous moisture. To take a press copy,



COAL OR OIL?

A cheap and adequate supply of fuel is essential to British industrial and domestic life. As a result of conditions arising from the Great War, coal is no longer cheap; nor is the supply adequate, decreased output being largely due to the reduction of the miner's working hours (as from 16 July, 1919) in accordance with the Sankey Report. Fortunately oil has been struck in Derbyshire. Can oil solve the great problem of the immediate future?

therefore, open the letter book at the last page used and place upon it an oiled sheet. Then with the brush dampen the sheets to be used or place the moist piece of linen in the book; then place the absorbent sheet between the leaf and the oiled sheet and slip the book into the copying-press, so that the binding at the back juts out just beyond the edges of the plates. Turn the wheel or pull round the lever, allow the book to remain a moment, and then take it out, for the superfluous moisture will have been absorbed.

You can now place your letter or document —two, three or four letters may be copied at a time—immediately behind the page in the book upon which it is to be impressed, taking care that there is an oiled sheet between each leaf in use, and, if you use linen sheets, that there is one of these also.

Again slip the book into the press, allowing it to remain for a moment or two, and when you remove it perfect copies should have been taken. Put away the linen sheets, extract the letters, but leave an oiled sheet between each newly used page until it has become quite dry, or else place the book somewhere with the leaves exposed so that they may dry more quickly, but not so that one damp leaf rests upon another.

Efficient Indexing

The efficiency of the indexing is quite as important as the neat and cleanly copying of the letters, and the junior who has charge of the letter book should make it a rule to index right up to the last letter of the afternoon before as one of his very first morning tasks. The system adopted generally for the indexing of letter books is to enter the name of the firm or individual to whom the letter is addressed, merely adding the further folios when subsequent letters are sent, and it is a good plan to add the name of the town after the title to avoid possible confusion. Items would, therefore, appear in the index like this:

Fry, Dawson & Co., Grahametown, 18, 21, 68, 79.

Poole, Reginald, Crewe, 45, 56, 63.

But the letter book should not merely be indexed so that a person in search of a letter would have to refer back to the index on finding that the first letter in the book was not the one he required. On the actual folios on which the letters are press-copied a kind of supernumerary index appears, which shows not only the folio of the letter immediately before the one under consideration, but also the letter after it.

Thus, in looking up the correspondence to Messrs. Fry, Dawson & Co., of Grahametown, instanced above, on folio 21 we should find in the top left-hand corner in blue pencil the figures $\frac{18}{68}$ set one above the other like a fraction, 18 signifying the last letter sent and 68 the subsequent one. Where no subsequent one had been sent the figure on the letter would be merely the folio of the last one dispatched, with the line underneath, thus: $\underline{18}$.

In the majority of offices, the junior who has charge of the letter book will also have the dispatch of correspondence as one of his duties. In all probability there will be many nights in the year when this work will keep him at his post long after the other clerks have gone, but he must not be tempted unduly to hurry through his task.

Guarding Against Error

Even in the actual dispatch of letters, trivial as the work may appear, there is a right way and a wrong one of approaching the task. Nothing is more annoying, for instance, than to enclose a letter in an envelope designed for another missive, and to avoid this error both letters and envelopes should be sorted in strict order into separate piles, and then if the last envelope matches the last letter there is little fear that a mistake has arisen.

It frequently happens that there are enclosures to go with letters—invoices, memoranda, specifications, estimates or other documents. When this is the case the correspondence clerk will type in a prominent position on the letter: 1 Enclo.; 2 Enclo.; or 3 Enclo., as the case may be, and the dispatch clerk must always be on the alert to see that the correct number of enclosures go with each letter, whilst should there be the slightest doubt he should read the letter and make himself conversant with the nature of the enclosures that ought to be sent.

Frequently a letter may come through marked "By Registered Post," and in this case the dispatch clerk must take it personally to the post office, obtain a receipt, and file that little docket in the appointed place. He must note, too, that before a registered package is accepted at a post office it must be sealed, and this task will fall to his share.

Even the simple matter of folding a letter is important in business. For the ordinary business-size envelope the letter is folded with the bottom of the sheet on to the top and then folded crossways three times.

A. B.

CHOOSING A CAREER.—II

Agriculture (*continued from p.* 60).—The supplies of our home-grown agricultural produce must be increased. This is indeed an essential part of the programme of reconstruction, and recent developments, legislative and otherwise, all tend to draw people back to the land in order that those who live crowded together in the centres of industry may at all events be supported upon the crops of our own soil.

Small Holdings.—For many years past, vegetables to the value of over 6¼ millions sterling have been imported annually from abroad, yet it is officially computed that there are in the British Isles nine million acres of land that are not cultivated, and upon which even timber is not grown. Some of this land is admittedly too bleak, too thin in soil, as to be hopelessly barren, but this does not apply to one-half of it, and these two facts as to colossal imports and large tracts of untilled land are utterly incompatible.

Everyone realises that the United Kingdom must grow more of her supplies; and tracts of land that have in the past been wasted are to be reclaimed to agriculture. Certainly there never was a more auspicious moment to embark upon a career that entails the wresting of a livelihood from the soil.

So far as small-holdings are concerned they stand proved to be most profitable where they have been managed by strong-willed, capable men and women. Naturally, the conduct of a miniature farm means much hard work and little leisure from year end to year end. In electing to become a small-holder a young man is setting himself a hard life's task, but at the same time he will always be his own master, he will always work in the pure, fresh air, and every spit of earth he turns or every ear of corn he cuts will be for his own personal benefit and not for the profit of an employer.

In order to set up as the tenant of a small-holding, a vast amount of purely technical knowledge must first be obtained. The majority of small-holdings in this country from which a family will derive its support are from five to fifty acres in extent; and that the land should be good and rich is of even more importance than on a large farm. Generally speaking, a holding is conducted with one main thread to its operations—dairying, for example. Grouped round this thread are various side-lines, such as pigs, poultry, vegetable growing, fruit, flowers for market, bees, a few sheep and so on.

The range of knowledge to be possessed by the successful small-holder must exceed even that of a farmer. Moreover, on a holding labour must be kept down to the minimum. The holder, his wife and family, therefore, must themselves perform as many of the tasks as possible. What usually happens is that the man assumes control of the major operations of the farm, leaving his wife to manage the poultry and perhaps the pigs, if these profitable creatures be kept.

As with general farming, so in the industry of small-holdings, the practical side is of the first importance, but a sound insight into theory is also required. What the would-be small-holder should do is to engage himself as a learner on a holding, and to accept gladly only meagre wages during this apprenticeship. If he can work for six months on a big general farm, so much the better, whilst six months at a specialist poultry farm would be of untold value. A short spell might also be worked in a market garden, and no opportunity should be lost of attending classes at local continuation schools in the arts of bee-keeping and also in the scientific subjects of farm chemistry, artificial fertilisers, drainage of land, composition of soils, and kindred subjects. Dairying, too, must be learnt—partly from first-hand experience, partly from teachers and books; and if the groundwork of marketing and salesmanship can be studied, so much the better.

Posts such as I have mentioned above are freely advertised in the local newspapers in agricultural districts, and particulars of classes may always be obtained by writing to the secretary of the County Council at the county town. Matters relating to bees are usually in the hands of the *British Beekeepers' Association, Bedford Street, Strand, London, W.C.*, which has branches and representatives in every part of the kingdom.

But even a would-be small-holder well equipped with knowledge of his craft must proceed cautiously when making an independent start. He must study, with a view to their fertility, plots of land offered him, and their natural advantages or disadvantages. He must consider the question of marketing his wares, and whether there are any small-holders' co-operative societies in the neighbourhood for the purchasing of foodstuffs, artificial manures and so on, and for the disposal of crops.

In some country-sides—near Evesham, in Worcestershire, for example — there are

colonies of small-holders who share the bigger agricultural implements, who sell their produce in bulk, and who are banded together in a society for the common weal or woe. If a future small-holder, either at home or in the Colonies, could work a year round on an Evesham allotment he would attain to a knowledge that would be hard to better.

Apart from all these considerations, however, there is the problem of capital to be faced. When undertaking the responsibilities of a hundred-acre farm from £20 to £30 an acre may be sufficient actual capital to possess, but on a small-holding everything is closely concentrated, and £50 an acre would be but a meagre allowance.

Again, though returns may come a little more quickly on a small farm than on a large one, the holder must live in the meantime. Every beginner, therefore, ought to possess enough to keep him with due economy for the better part of a year after commencing, in addition to the capital he is prepared to sink into the enterprise.

It is not possible, even roughly, to reduce the actual prospects of a small-holder to figures. At the same time, with good husbandry and careful management, a holding of from five to ten acres at a reasonable rental ought to provide a comfortable living for a man and his family ; and, under skilful organisation, the value of his worldly stock and possessions ought steadily to mount until he can transform the small-holding into a larger one. In fact, a small-holding is an ideal stepping-stone to a large farm, or to a ranch across the seas.

Dairy Farming is a special section of agriculture. Naturally, one finds the majority of dairy holdings in the neighbourhood of great cities, where the produce is dealt with by a co-operative society.

More capital is required to commence a dairy farm, and the farmer must possess a specialised knowledge of his own. Apart from the care of stock and the obtaining of the greatest supply of milk from the smallest outlay, there are questions of butter and cheese making to be mastered. As with all other branches of agriculture, the only way efficiently to start life as a dairy farmer is to serve an apprenticeship as a working learner, to study at County Council and other classes, and not to be content with acquiring only the methods of one part of the country.

Poultry Farming pure and simple is also in a class unto itself—and a very important class too. Unfortunately, only too often middle-aged people blessed with a slender income set up as poultry farmers with an altogether insufficient knowledge of the craft. Failure in these circumstances is inevitable. In fact, there are more actual failures agriculturally with poultry than any other class of stock, simply because so many amateurs dabble in what is, after all, a calling that requires the training of a super-specialist.

At first glance, it looks so simple to keep fowls and make a handsome profit, but there are difficulties to be faced that quickly bring the truth to light. Soil, for example, has a great bearing upon success with poultry, and even the most suitable soils are quickly soured unless precautions are taken. Then there is marketing to be considered, judicious advertising, the purchase of foodstuffs, and a hundred other details.

Without any doubt, poultry can be made to pay, because there are many prosperous poultry farmers. The business, however, is full of traps and snares, and should be approached only with a full and definite knowledge of the conditions, such a knowledge as is obtainable either as a working or premium apprentice on a practical poultry farm. The poultry press contains each week advertisements for such apprentices, and where premiums are charged they are not unduly high or unreasonable, considering that their payment ensures the means of gaining a good livelihood.

Poultry farming is, of course, subdivided into many side issues. There is the raising of high-class show birds, an art and industry in itself ; the growing of birds for table use, which includes caponising, cramming and other special tasks ; the keeping of birds solely for laying purposes, and the running of farms from which stock is supplied to other farms. Geese, turkeys and ducks are further side-lines, and there are actually profitable farms where no stock but ducks is kept at all, the ducklings being forced and turned upon the market for table use when they are only eight or nine weeks old.

To start as a poultry farmer, first learn all you can from practical experience. Further, begin in a small way, sticking tenaciously to your capital and increasing the size of your holding slowly and with great caution. You will, if you bear this in mind, keep your losses within reasonable bounds, and profit by your steady and careful work. Because a dozen hens in a suburban garden can be made to yield a handsome profit, it does not follow that a thousand birds on five or six acres are going to pay in similar proportion.

A. C. M.

BOOK-KEEPING.—II

THE book which will be considered in this lesson is one which, if properly kept, will in itself enable a man to ascertain at any moment the exact position of his financial affairs. This book is known as the **Ledger,** the most important of all books of account.

The various records in the Ledger are called **Accounts,** and, unlike those in the Journal, they are not entered in chronological order, but are classified under the distinct heading to which they relate. Thus everything relating to W. Lees appears in W. Lees' Account; all that concerns goods is entered in the Goods Account (purchases or sales, as the case may be); that which has reference to capital is found in the Capital Account, and so on. By this means a man can, by reference to his Ledger, ascertain such facts as the amount owing to or by W. Lees, the money paid away for wages for any period, the value of goods he holds, etc.

The transactions of A. Venture given in the last lesson are reproduced below in Journal form, so that the student may follow the process at a glance. In order that the folio column may be filled in, the Journal will be looked upon as being at page 1, and the Ledger Accounts will be numbered consecutively.

Two features to remember are:

1. Every Debit has a Credit.

2. The name of an account must not appear in that account. For example, in the first item in the Journal, on January 1st, Cash is not debtor to Cash, but to Capital.

Every item which appears in the Debtor column of the Journal is posted to the Debtor side of the Ledger, and every item appearing in the Credit column of the Journal is posted to the Credit side of the account concerned in the Ledger.

In actual practice the Ledger is seldom written up or "posted" from the Journal, but the particulars posted to the Ledger are taken from the book of original entry.

In order to test the posting a Trial Balance is made, and this will appear as follows:—

TRIAL BALANCE

		Dr.				Cr.	
Capital	1				500	–	–
Cash	2	520	–	–	110	–	–
Purchases	3	187	10	–			
Sales	4				25	–	–
W. Lees	5	100	–	–	150	–	–
A. Shaw	6				37	10	–
F. Smith	7	25	–	–	20	–	–
Wages	8	10	–	–			
		£842	10	–	842	10	–

The same result can be achieved by taking the differences between the Debit and Credit side of each account:—

TRIAL BALANCE

		Dr.				Cr.	
Capital	1				500	–	–
Cash	2	410	–	–			
Purchases	3	187	10	–			
Sales	4				25	–	–
W. Lees	5				50	–	–
A. Shaw	6				37	10	–
F. Smith	7	5	–	–			
Wages	8	10	–	–			
		£612	10	–	612	10	–

JOURNAL (1)

				Dr.			Cr.		
19.. Jan.	1	Cash Dr.	2	500	–	–			
		To Capital	1				500	–	–
„	2	Purchases Dr.	3	150	–	–			
		To W. Lees	5				150	–	–
„	3	F. Smith Dr.	7	25	–	–			
		To Sales	4				25	–	–
„	7	W. Lees Dr.	5	100	–	–			
		To Cash	2				100	–	–
„	9	Purchases Dr.	3	37	10	–			
		To A. Shaw	6				37	10	–
„	15	Cash Dr.	2	20	–	–			
		To F. Smith	7				20	–	–
„	21	Wages Dr.	8	10	–	–			
		To Cash	2				10	–	–
				£842	10	–	842	10	–

LEDGER

CAPITAL ACCOUNT (1)

Dr.						Cr.					
19..						19..			£	s.	d.
						Jan. 1	By Cash	1	500	–	–

CASH ACCOUNT (2)

Dr.			£	s.	d.	Cr.			£	s.	d.
19..						19..					
Jan. 1	To Capital	1	500	–	–	Jan. 7	By W. Lees	1	100	–	–
„ 15	„ F. Smith	1	20	–	–	„ 21	„ Wages	1	10	–	–

PURCHASES ACCOUNT (3)

Dr.			£	s.	d.	Cr.					
19..											
Jan. 2	To W. Lees	1	150	–	–						
„ 9	„ A. Shaw	1	37	10	–						

SALES ACCOUNT (4)

Dr.						Cr.			£	s.	d.
						19..					
						Jan. 3	By F. Smith	1	25	–	–

W. LEES (5)

Dr.			£	s.	d.	Cr.			£	s.	d.
19..						19..					
Jan. 7	To Cash	1	100	–	–	Jan. 2	By Goods	1	150	–	–

A. SHAW (6)

Dr.						Cr.			£	s.	d.
						19..					
						Jan. 9	By Goods	1	37	10	–

F. SMITH (7)

Dr.			£	s.	d.	Cr.			£	s.	d.
19..						19..					
Jan. 3	To Goods	1	25	–	–	Jan. 15	By Cash	1	20	–	–

WAGES ACCOUNT (8)

Dr.			£	s.	d.	Cr.
19..						
Jan. 21	To Cash	1	10	–	–	

Commercial Terms

Narrations : These are explanations after an entry made in any book, but more particularly the Journal. For example, the first Journal entry given in the previous exercise might have added to it by way of explanation, "being the amount invested by A. Venture in the business." Narrations are seldom used in elementary work, but frequently appear in more advanced book-keeping, particularly in Company Accounts.

Stocktaking : This is the process of valuing the saleable goods on hand, and is generally done at fixed periods. The process will be explained later.

Book Debts : These are the amounts owing to the business by sundry persons, and are, in fact, the Debit balances in their accounts.

F. H.

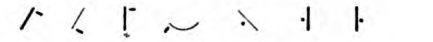
SHORTHAND.—II

(Continued from p. 64)

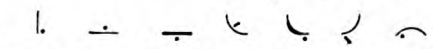
Key to Exercise 7.

1. mow. maw, gnaw, raw, row, rue, woe, woo.
2. air, low, law, lieu, hoe, hay, ray, re.
3. chew, rue, jaw, raw, shoe, lay, foe, show.
4. fee, caw, Goe, ape, toe, oar, foe, she.

Key to Exercise 8.

1. 

2.

3. 

Grammalogues.—Many of the common words in our language are represented by a form which is some part of the full word, as in St. = street, Dr. = doctor, Rd. = road, and these abbreviations have to be memorised before they can be used with ease and certainty. A similar method is followed in Pitman's Shorthand, and the words that are represented by an abbreviated form are called *grammalogues.* Here are a few for the student to learn—

..... *a* or *an*, . *the* ; ..... *all*, ↖ *too, two* ; ..... *of*, ↖ *to* ; ..... *owe*, ı *he* ; ..... *ought*, ↗ *who* ; ..... (up) *and*, ↗ (up) *should* ; ..... *on*, ı *but.*

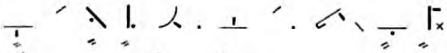
Heavy signs are always written downward. As the above signs are given in pairs, there is an excellent opportunity of remembering them in pairs. They should be learned now, and thus simplify the study of shorthand in the future.

The following exercises contain all the grammalogues mentioned above.

Exercise 9.

A small cross, thus ×, *indicates a fullstop.*

1.

2. 

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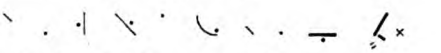
4. 

5.

Key to Exercise 9.

1. *He should* pay *all he* owes *to* Esau Day.
2. Joe Coe *and* Abe Dee show *the* oak *and the* yew *to* Kaye Dawe.
3. *He ought to* row *on the* bay.
4. *Two of the* eight pay *a* fee *to the* gay Jew.
5. Joe *and* Abe *owe all to* pa *and* ma.

A knowledge of all the grammalogues in this exercise is very necessary, and if the student finds difficulty in this respect in turning the key into shorthand, he should memorise the forms before proceeding farther.

Short Vowels.—Besides the long vowels there are six short vowels, as follows—

ă *ĕ* *ĭ* *ŏ* *ŭ* *ŏŏ*

as heard in the syllables

ăt *ĕt* *ĭt* *ŏt* *ŭt* *ŏŏt*

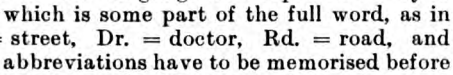
These are represented by a light dot and a light dash written in the same places as the long vowels ; thus—

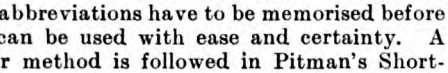
ă	1		1	*ŏ*
ĕ	2		2	*ŭ*
ĭ	3		3	*ŏŏ*

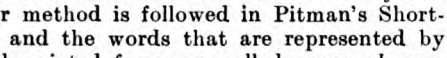
Here are the outlines for a few words containing short vowels—

| *add*, / *edge*, / *itch*, | *odd.*

Exercise 10.

1. 

2. 

3. 

Key to Exercise 10.

1. ash, Ann, ass, ebb, err, Oddy, Addy, Uddy.
2. ill, eel, odd, awed, arrow, era, alley, abbey.
3. Ella, echo, Eva, Anna, Ada, etch, eddy, Asia.

Deal with this key as in the case of previous exercises.

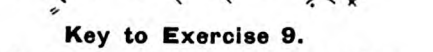
Perhaps the words *err, arrow,* and *era* gave a little cause for hesitation, as to whether the upward or the downward form of *r* should be written. A simple rule will clear up the matter : If a vowel precedes *r*, the downward form of *r* is written ; if no vowel precedes, the upward *r* is used ; thus—

↘ *array*, but ↗ *ray* ; ↖ *arrow*, but ↗ *row.*

Joined Strokes.—A majority of words require outlines of more than one stroke, and the question of joining the strokes of the alphabet must now be dealt with. Here are some examples of joined strokes—

tp, chp, fb, thch, rb.

tr, chr, bl, thl, sl.



tm, bk, rk, shm, sk.

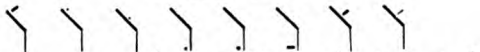
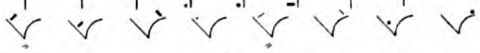
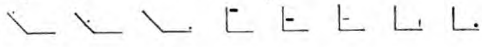
Note in all these cases that the downstroke is written on the line whether followed by a downstroke, an upstroke, or a horizontal.

By the aid of the long and the short vowel-signs, many new words can now be written—

1. *far, fad ; doll, tall.*
2. *dale, dell ; pore, purr.*
3. *teak, tick ; pool, pull.*

It follows from these examples that first-place and second-place vowel-signs between two strokes are written to the first stroke; and that third-place vowel-signs between two strokes are written to the second stroke at the end. The student should write out the above outlines many times in order to become familiar with the places of vowels between two strokes.

Exercise 11.

1. 
2. 
3. 

Key to Exercise 11.

1. bought, bat, bet, bit, beat, boot, boat, butt.
2. Paul, pole, pool, pal, Poll, pull, pale, peal.
3. pack, peck, pick, talk, toque, tuck, took, teak.

The student's attention is now drawn to further lists of examples—

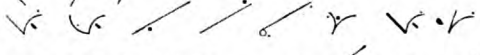
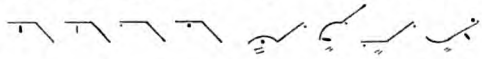
1. *yellow, roar, wore, yore.*
2. *hope, reap, wood, wreath.*
3. *wreck, honey, awake, yoke.*

Note that the upstroke begins on the line whether followed by an upstroke, a downstroke, or a horizontal, and putting together what has been said about joined strokes, the following rule may now be given: The first downstroke, or the first upstroke, rests on the line of writing.

1. *cape, code, coffee, meadow.*
2. *cool, carry, merry, narrow.*
3. *comb, game, name, many.*

Whether a downstroke or an upstroke follows a horizontal, the downstroke or the upstroke rests on the line; therefore, in line 1, the horizontals start above the line to allow of the downstrokes resting on the line. Two horizontals —line 3— rest on the line.

Exercise 12.

1.
2. 
3. 

Key to Exercise 12.

1. shape, fetch, thatch, match, watch, rat, lame, lock.
2. pillow, fellow, rare, rear, Harry, assail, billow, chill.
3. cope, cup, cap, cape, Mary, Laura, Carrie, Nero.

Upward and Downward R.—As already explained in this lesson, *r* is written downward if a vowel precedes, and upward if a vowel does not precede; thus—

ark, rack; arena, rainy; Arab, rob.

In other words, *r* is used to show the presence or absence of an initial vowel. However, to make this rule always apply would result in awkward joinings, and so in certain cases this rule is ignored; thus—

ram, ream; aright, earth.

Hence, initial *r* is always written downward before *m*; and upward before | | // ((

Awkward forms are a hindrance to fast writing, and that is why stress is laid on this matter.

Again, the following pairs of examples should be studied—

fair, fairy; gore, gory;

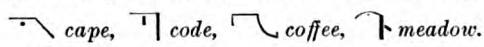
dare, Derry; lore, Laura.

Where *r* ends a word, the downward form is written; where a final vowel is preceded by *r*, the upward form is written. This rule, together with the one on initial *r*, is most important.

Exercise 13.

GRAMMALOGUES.

happy, up, put; by, buy, be, to be; at, it, out.

1. 
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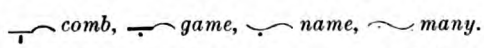
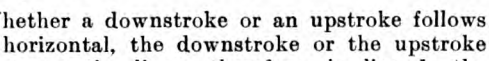
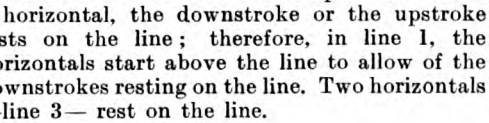
3. 
4. 
5. 

Exercise 14.

GRAMMALOGUES.

had, do, difference-t; much, which, each.

1. Tom *had to* take *the* barrow *to the* ferry.
2. *Each* fellow *had to* read *a different* page *of the* form.
3. *He* paid *much* money into *the* bank *to*-day.
4. *Which* shop showed *a* big *difference of* cash *on* Monday?
5. *He had to* make *up the* Petty Cash Book *at* four *each* day.
6. *The* cargo *of* coffee, cocoa, *and* tea should reach *the* dock *to*-morrow.

From the painting by E. Corbould.

CANTERBURY PILGRIMS AT THE TABARD INN, SOUTHWARK,

where Chaucer supposes his pilgrims to have assembled. The old Inn, situate in the High Street, near the Kent Road, was condemned in 1866 and demolished soon after, a freight depot of the Midland Railway being constructed on the site.

Continued from page 74

ENGLISH LANGUAGE AND LITERATURE:

Contributors:—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

GEOFFREY CHAUCER

GEOFFREY CHAUCER was the son of John Chaucer, a wine merchant of Suffolk descent, living in Thames Street, London, and apparently connected by way of business with the Court of Edward III. The year of Geoffrey's birth was long mistaken. Indeed, nearly all the events of his life have been ascertained in comparatively recent times. William Godwin published, in 1803, a *Life of Chaucer* which was regarded for some time as a standard work, but contained scarcely a statement that has not been proved definitely wrong.

Court Associations

The growth of historical material with the lapse of time is illustrated almost sensationally in Chaucer's case. A hundred and fifty years ago his life was compounded from tradition and guesswork; now it is exceptionally well known.

Our knowledge, however, does not identify the year when he was born. It certainly was not 1328, the date put on his sixteenth century tomb. It must have been about 1340, for in April, 1357, he was a page in the household of Elizabeth, wife of Prince Lionel, son of Edward III., who fitted him up with clothes at a cost of about five pounds of present-day money. Two years later he was in France, at the wars, either as a member of the household of Lionel or of the King, and was there captured.

Chaucer had a knack of falling into these misadventures, for we know that twice in later life he came into the clutches of highwaymen. The King thought him, at the age of nineteen, or thereabouts, sufficiently useful to be ransomed from the French at a cost of about £200 present value.

For the next seven years we know little of his life except that he married one of the ladies of the Queen's chamber, who, in 1366, was granted for life a yearly pension of ten marks (about £150 in present value), and next year Chaucer himself was granted a life pension of twenty marks, as one of the yeomen of the King's chamber, and shortly after was made "an esquire of less degree."

At this time, and later, Chaucer was closely associated with that energetic prince, John of Gaunt, Duke of Lancaster, who, for his third wife, married a sister of Chaucer's wife, Philippa. In the declining years of Edward III. political interest was divided between the party of the Black Prince and the party of his brother, John of Gaunt, and Chaucer was naturally a close adherent of the Gaunt cause, which, it may be remembered, incidentally viewed with favour the anti-clerical movement headed by John Wycliffe.

Meeting with Petrarch

Between 1369 and 1379, Chaucer was frequently abroad, in France, in Flanders, and in Italy, on the King's service, and met Froissard the Chronicler, Petrarch, and possibly Boccaccio. On his return he filled important offices of profit, including the controllership of the Customs and Subsidy of Wools and Hides in the Port of London, and he received a second pension from the King and a pension from John of Gaunt.

As an official with intimate Court influence, large emoluments, and the position of knight of the shire for the county of Kent, he must have had quite a considerable position. But after the year 1387, when John of Gaunt was absent from the country and his power under eclipse, the poet suffered great fluctuations of fortune. More than once he was stripped of his offices and suffered financial straits. No doubt he found more

time for writing during these periods of acute reverse. Richard II., however, befriended him from time to time, and when Henry of Lancaster, son of John of Gaunt, seized the throne as Henry IV., the financial worries of the poet's later years were ended, his affluence was restored, and he died in comfort in October, 1400, an old man at sixty.

By this time his fame as a writer, both in England and abroad, had already made his experience as a man of affairs appear of quite secondary importance. It was felt that a new star had arisen in the literary firmament. By the amusement of his leisure hours Chaucer remains known; but it is well to remember that no other English writer, not even John Milton or John Locke, occupied an equal position as man of affairs. His range of experience was great. As Lowell says, "scholar, courtier, soldier, ambassador, he had known poverty as a housemate, and had been the companion of princes."

A XIV Century Education

Apparently Chaucer began to write comparatively late in life. His first extant poem that can be dated with confidence, *The Death of Blanche, the Duchess*, commemorating the first wife of John of Gaunt, could not have been written before Chaucer's thirtieth year, for the duchess died in 1369. Not till his fortieth year could the poet's style be said to have become matured, and his full power was not shown till after he was forty-five.

What was his relationship to authorship during his earlier years? How was he educated?

Once it was inferred, from poems attributed to him, that he had studied at Oxford and at Cambridge, but there is no sound evidence to that effect. Means of education were around him all his life, and we know he was a book-lover, and absorbed learning wherever he went. The changing of his studies and of his literary sources of interest as he travelled prove that. Latin, French, and English were in common use in the circles where he moved. English had been brought back to Parliament in 1362, and in the same year it superseded French in the Law Courts.

Chaucer showed he had a fair working command of Latin in his prose translation of *The Consolation of Philosophy* by Boëthius. French and English might probably be equally called his native tongue, though French, as we know from his writings, was falling back into the position of a foreign language. His earliest poetry, before the *Death of the Duchess*, was apparently confined to the translation of French romances into English. Some of these have been lost, and the best-known, *The Romaunt of the Rose*, the most popular poem of the day, comes to us in such a form that only a part of it can be accepted as the version which Chaucer tells us he produced.

The visits to Italy brought the poet into touch with Italian literature, and before he settled down to his chief literary labours he had already begun to adopt Italian models and to borrow his subjects from Italian sources, though he gave them original and often distinctively English treatment. As was the custom of his time, he found his building material anywhere; but he cast it in an English mould.

To about the same time as the *Duchess* poem belongs the *Complaint unto Pity*, bewailing an apparently unrequited love that seems to be personal. This was the first poem in English in rhyme-royal—a seven-line verse with ten syllables and five beats to the line. *The Parliament of Birds*, an allegory commemorating the marriage of Richard II. and Anne of Bohemia—a marriage which Chaucer had taken part in arranging—dates from 1382.

The Canterbury Tales

Troilus and Creseyde shows the growing influence of Italy on the poet. It is partly a translation of Boccaccio's *Il Filostrato*, but is made into an original poem by the poet's individual treatment of the theme, and it marks not only a great increase in literary skill, but a free use of the deep vein of quiet humour which afterwards was so conspicuous.

The poet now began several works that remained unfinished—*The House of Fame*, reminiscent of Dante, and the *Legend of Good Women*, intended for presentation to the Queen. It is a recital of nine instances of woman's hopeless love, a subject touched on also in *The House of Fame*. These poems, with some shorter verses of a later date, such as the poet's *Complaint to His Purse*, written when he was reduced to comparative poverty, and his verses on *Lack of Steadfastness* and *Truth*, each with an intensely personal note, complete the list of writings that need be mentioned here outside of the master work, *The Canterbury Tales*.

If Chaucer had not written *The Canterbury Tales* he still would have been by many magnitudes the brightest star in the firma-

ment of his country's literature before Elizabethan times, for he had brought variety of melody into English verse and a new quality of humour; but through the *Tales* he takes a far more refulgent place than could have been claimed for him because of his other writings.

The plan of the *Tales* allows a freedom and scope that enabled the poet to reflect a great part of the life of his generation, and the whole work is saturated with the English spirit.

In the *Tales* the poet pictures the casual gathering at the Tabard Inn, in Southwark, of nine and twenty people who are about to start on a pilgrimage to the shrine of Saint Thomas à Beckett at Canterbury. The concourse represents almost the whole range of the society of that period—knight and squire, landholder and local official, the Church under its many phases, favourable and unfavourable, tradespeople, craftsmen, labourers, law and physic, the courteous, the prim, the vulgar of both sexes, and the vagabonds of the road.

The very mixed company is welded into a sort of unity by the activity and robust good sense of the landlord of the Tabard, Harry Bailly. He it is who proposes that they shall brighten their travels by tale-telling, each pilgrim telling two tales on the way to Canterbury and two returning, and the best tale-teller shall afterwards be entertained at supper at the Tabard by the whole company. Mine host himself will accompany them as guide, master of ceremonies, umpire and autocrat, and offers them his head if they be not merry.

This general plan allows the poet to use up a number of stories he had previously written by making a suitable member of the company the mouthpiece for each story. Some of these older stories are recognised as such by their style, and because they are below the standard of the poet's work at the time when the pilgrimage was planned. Many of the stories, however, are new. Some remain unfinished, and the whole book is also incomplete, perhaps because the poet died while it was in the making, or perhaps because he grew tired of tale-telling. The scheme, however, suffices to give an English form to a number of stories, old and new, and in the Prologue, introducing the characters, and the narrative which connects the stories, it preserves for all time a panorama of the life of Chaucer's day.

GEOFFREY CHAUCER.

From the portrait, on wood, in the Bodleian Library, Oxford. This portrait being comparatively late is traditional rather than authentic. *cf.* **Occleve's portrait on p. 71.**

One or two suggestions must be made respecting the reading of Chaucer now. Whoever reads him in such a way as to make him sound hobbling in his march, or unmelodious in rhythm, is reading him wrongly, and is not allowing either for terminal syllables which the Teutonic element in the language had not yet entirely cast off, or for the accent on the last syllable of words from the French, which had not yet been changed by our English tendency to move stresses back to the first syllable.

The opening lines of the Prologue to *The Canterbury Tales* illustrate that love of Nature in Chaucer which makes the reading of him seem, as Lowell said, "like a walk in the morning air":

When that Aprillé with his showrés soot (*sweet*)
The drought of March hath pierced to the root,
And bathéd every vein in such liquór
Of which virtúe engendered is the flower,
When Zephirus eke with his sweeté breath
Inspiréd hath in every holt and heath
The tender croppés, and the youngé sun
Hath in the Ram his halfé course y-run,
And smallé fowlés maken melodye
That sleepen all the night with open eye—
So pricketh them Natúre in their coráges— (*hearts*)
Then longen folk to go on pilgrimages.

Here it will be noted, not only that extra syllables are marked, but that in *liquor*, *virtue*, *nature*, and *corages* all have the stress on their second syllables.

Chaucer's power of narrative, as easy as talk, may be sampled from lines that almost immediately follow:

Befell it in that season on a day,
In Southwark by the Tabard as I lay,
Ready to wenden on my pilgrimage
To Canterbury, with full devout coráge,
At night were come unto that hostelrye,
Well nine-and-twenty in a companye,
Of sundry folk, by áventure y-falle (*chance*)
In fellowship, and pilgrims were they all,
That toward Canterbury wolden ride.

The Gentle Knight and——

The poet then gives thumb-nail portraits of all the principal members of the company, clear in outline, shrewd in insight, tender in feeling, and played over by a benignant humour. Here is the Knight:

A Knight there was and that a worthy man,
That from the timé that he first began
To riden out, he lovéd chivalry,
Truth and honoúr, freedom and courtesy.
Full worthy was he in his lordés werre, (*war*)
And therto had he ridden, no man ferre. (*further*)
At mortal battles had he been fifteen,
And foughten for our faith at Tramysene
In listés thriés, and aye slain his foe. (*thrice*)
This ilké worthy Knight had been also (*same brave*)
Sometimé with the lord of Palatye
Against another heathen in Turkye,
And evermore he had a sovereign prize.
And though that he was worthy he was wise, (*brave*)
And of his port as meek as is a maid,
He never yet no villainy ne'er said
In all his life, unto no manner of wight.
He was a very perfect gentle Knight.

The delightful picture of the Young Squire must be added:

With him there was his son, a young Squiér,
A lovyere and a lusty bacheler, (*lover*)
With lockés crulle as they were laid (*locks curled*) in press,
Of twenty year of age he was, I guess.
Of his statúre he was of even length,
And wonderly delyvere and great of (*nimble*) strength.
And he had been sometime in chyvachie (*active service*)
In Flanders, in Artoys and Picardy,
And borne him well, as of so little space,
In hope to standen in his lady's grace.
Embroidered was he, as it were a mead
All full of freshé flowrés white and rede. (*red*)
Singing he was or fluting all the day,
He was as fresh as is the month of May.
Short was his gown, with sleevés long and wide.
Well could he sit on horse and fairé ride.
He couldé songés make and well indite,
Joust, and eke dance, and well pourtray and write;
So hot he lovéd that by nightertale
He slept no more than doth a nightingale.
Courteous he was, lowly, and serviceáble
And carved before his father at the table.

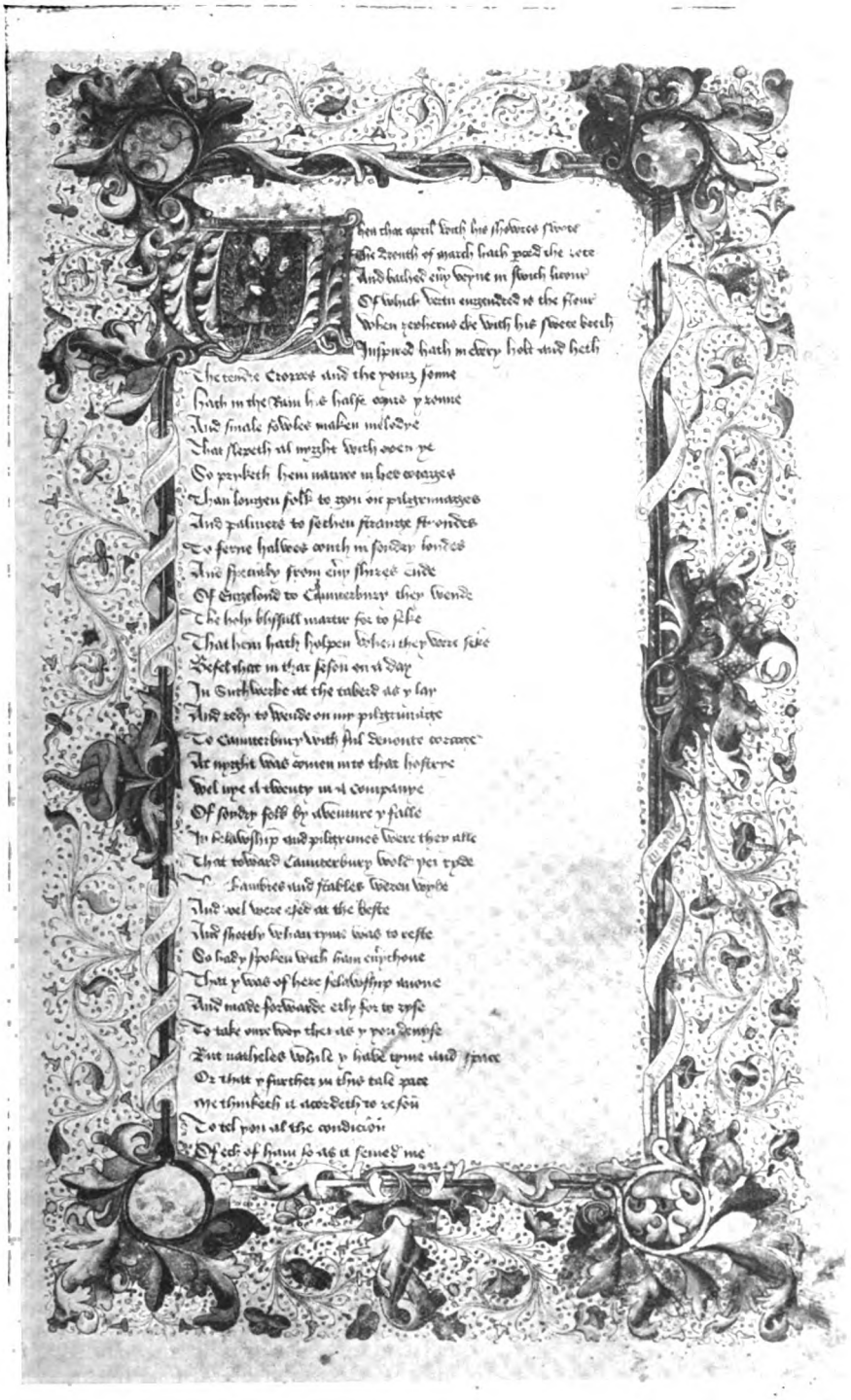
——the Poor Scholar

The figure of the Poor Scholar once seen can never be forgotten:

A Clerk there was of Oxenford also,
That unto logic haddé long y-go. (*gone*)
As leané was his horse as is a rake,
And he was not right fat, I undertake,
But lookéd hollow, and therto soberly;
Full threadbare was his overest courtepy; (*uppermost cape*)
For he had gotten him yet no benefice,
Nor was so worldly for to have office;
For he would liever have at his bed's head
Twénty bookés, clad in black or red,
Of Aristotle and his philosophie,
Than robés rich, or fiddle, or gay psaltrie;
But all be that he was a philosóphre
Yet haddé he but little gold in cófre;
But all that he might of his friendés hente (*take*)
On bookés and his learning he it spent,
And busily 'gan for the soulés pray
Of them that gave him wherewith to scoleye (*study*)
Of study took he most care and most heed,
Not a word spoke he mooré than was need,
And that was said in form and reverence,
And short and quick and full of high senténce.
Sowning in moral virtue was his speech, (*tending to*)
And gladly would he learn and gladly teach.

From the whole gallery of portraits the one that stands out most clear, as the forerunner of all the devoted men of religion ever sketched in fact or fiction, is the Parish Parson. On it Chaucer lavished his large-hearted humanity.

A good man was there of religióun,
And was a pooré parson of a town;
But rich he was of holy thought and work
He was also a learnéd man, a clerk,



THE PROLOGUE TO THE CANTERBURY TALES.

Reproduced from MS. 686, a fifteenth-century illuminated manuscript in the Bodleian Library, Oxford.

That Christés gospel truély would preach;
His parish'ners devoutly would he teach.
Benign he was and wonder diligent,
And in adversity full patiént;
And such he was y-proved ofté-sithes (*often-times*)
Full loth were he to cursen for his tithes,
But rather would he given, out of doubt,
(*undoubting*)
Unto his poor parishioners about,
Of his offring and eke of his substánce.
He could in little thing have suffisánce.
Wide was his parish, and houses far asunder,
But he ne lefté not for rain or thunder,
(*left not off*)
In sickness nor in mischief to visíte
The furthest in his parish, much and lite, (*little*)
Upon his feet, and in his hand a staff.
This noble ensample to his sheep he yaf, (*gave*)
That first he wrought and afterwards he taught.

* * * * *

A better priest, I trow, that nowhere none is,
He waited after no pomp and reverence,
Nor maked himself a spicéd consciénce,
But Christés lore and his Apostles twelve
He taught, but first he followed it himselve.

Chaucer Describes himself

The sketcher of delightful portraits happily has left us several portraits of himself. Thus we see him as he appears to mine host of the Tabard, when that worthy demands a tale from him:

And then at erst he lookéd upon me,
And saydé thus: "What man art thou?" quod he;
"Thou lookest as thou wouldest find an hare,
For ever upon the ground I see thee stare.
Approaché near, and look up merrily.
Now ware you sirs, and let this man have place;
He in the waste is shaped as well as I;
This were no poppet in an arm t'embrace
For any woman, small and fair of face.
He seemeth elvish in his countenance,
For unto no wight doth he dalliance."

Chaucer pleads that he can only repeat a rhyme he learnt long ago, whereupon mine host:

"Yea that is good," quod he, "now shall we hear
Some dainty thing, me-thinketh by his cheer."

The *Tale of Sir Thopas* that follows is a sly satire on the foolish long-drawn-out rhyming romances of the past, and by the time Chaucer has droned a couple of hundred lines:

"No more of this for Goddés dignitee"
Quod ouré hosté, "for thou makest me
So weary of thy very lewedness
That also, wisely God my soulé bless,
Mine eárs achen of thy drasty speech.
Thou doest naught else but despendest (*waste*) time
Sir, at a word, thou shalt no longer rhyme."

Whereupon Chaucer substitutes a tale in prose as his part of the entertainment. Another of the poet's pictures of himself is given in *The Legend of Good Women:*

And as for me, though that I ken but lite,
(*know but little*)
On bokés for to read I me delight,
And to them give I faith and full credénce,
And in mine heart have them in reverence
So heartily that there is gamé none
That from my bokés maketh me to gone,
But it be seldom on a holyday,
Save certainly when that the month of May
Is comen, and that I hear the fowlés sing
And that the flowerés ginnen for to spring—
Farewell my book and my devotión.

And, lastly, there is an account of how the poet spent his leisure during his period of active public service. It is from the *House of Fame:*

Thou hast no tidíngs
Of Lovés folks, if they be glade
Nor of nothing ellés that God made,
And not alone from far countrie
That there no tiding cometh to thee,
But of thy very neighébours,
That dwellen almost at thy doors,
Thou hearest neither that nor this,
For when thy labour done all is,
And thou hast made thy reckonings,
Instead of rest and newé things
Thou gost home to thy house anoon, (*anon*)
And, also dumb as any stoon
Thou sittest at another book,
Till fully dazéd is thy look,
And livest thus an herémite,
Although thine abstinence is lite. (*little*)

The Poet's Character

This, then, is the view we get of Chaucer from Chaucer—not a picture of a man of affairs who has served his country in courts and in the tented field, though that was half his life's experience, but of a rather lonely man, living with his books and his own thoughts, yet with an eye that nothing escapes when he mixes with his fellows, a man with an inveterate sense of humour, which turns upon himself as readily as upon the world which he loved.

For a large part of his life, Chaucer was content to mirror the world in his writings, a world so rough in many ways that it shocks our modern susceptibilities. Indeed, there came a time when he wished he had shown a finer delicacy. In that wish every modern reader will join, for the mediæval grossness of some of his stories unfits them for general reading now. In general, however, his work was that of a shrewd and sage observer of life, who mingled manly resignation and idealism with much worldly wisdom. J. D.

SPECIAL SUBJECTS

No. I.—THE FUEL QUESTION: SOME FACTS AND FIGURES

In the building-up of British trade, i.e. in increasing the total of our imports and exports from 81 million pounds sterling in the year 1820 to nearly 1,700 millions within the passing of a century, coal has played a leading part.

In effect, we have changed our great natural resources in coal for food and the raw materials upon which our manufacturing industries were, in a present-day sense, founded.

Standing fast upon our island home we have offered our coal to the world, and for the 73½ million tons we had to sell in a recent year we received from other nations in exchange a goodly proportion of our grain and flour; meat and provisions; sugar; textile material and all the other heterogeneous imports that have gone to make our commerce.

And, further, not only does coal represent the largest bulk of raw materials that we have to export, but it has also in no small measure contributed to make us the possessors of our mammoth mercantile marine. For the ships that have taken the black diamonds from our shores have brought back to us in due course the proceeds of the bartering and exchange.

300 %!!

To put it in another way, without all the concentrated wealth represented by the British coalfields we had nothing to offer other nations in return for raw materials by reason of our very smallness and our insular position. Without our coal we could not have formed our mercantile fleet; we could not have supported ourselves with foodstuffs from every corner of the globe; and we could not have obtained those unmanufactured materials that form the very backbone of our industrial life.

But even when considering the products of our coal from distant lands we are only on the fringe of the greatest economic problem we have ever faced. In the year 1899 we exported coal to the value of 21 millions sterling; within fifteen years the value had exceeded 50 millions sterling, the enormous difference being partially due to increased cost of production, but mainly to enlarged output.

Yet even this 50 millions of pounds only bought 73½ million tons of our coal, whereas the 287½ million tons of coal raised in one recent year was valued at the pithead at 145½ millions sterling. In other words, *for every ton of coal we export we burn nearly three tons at home.*

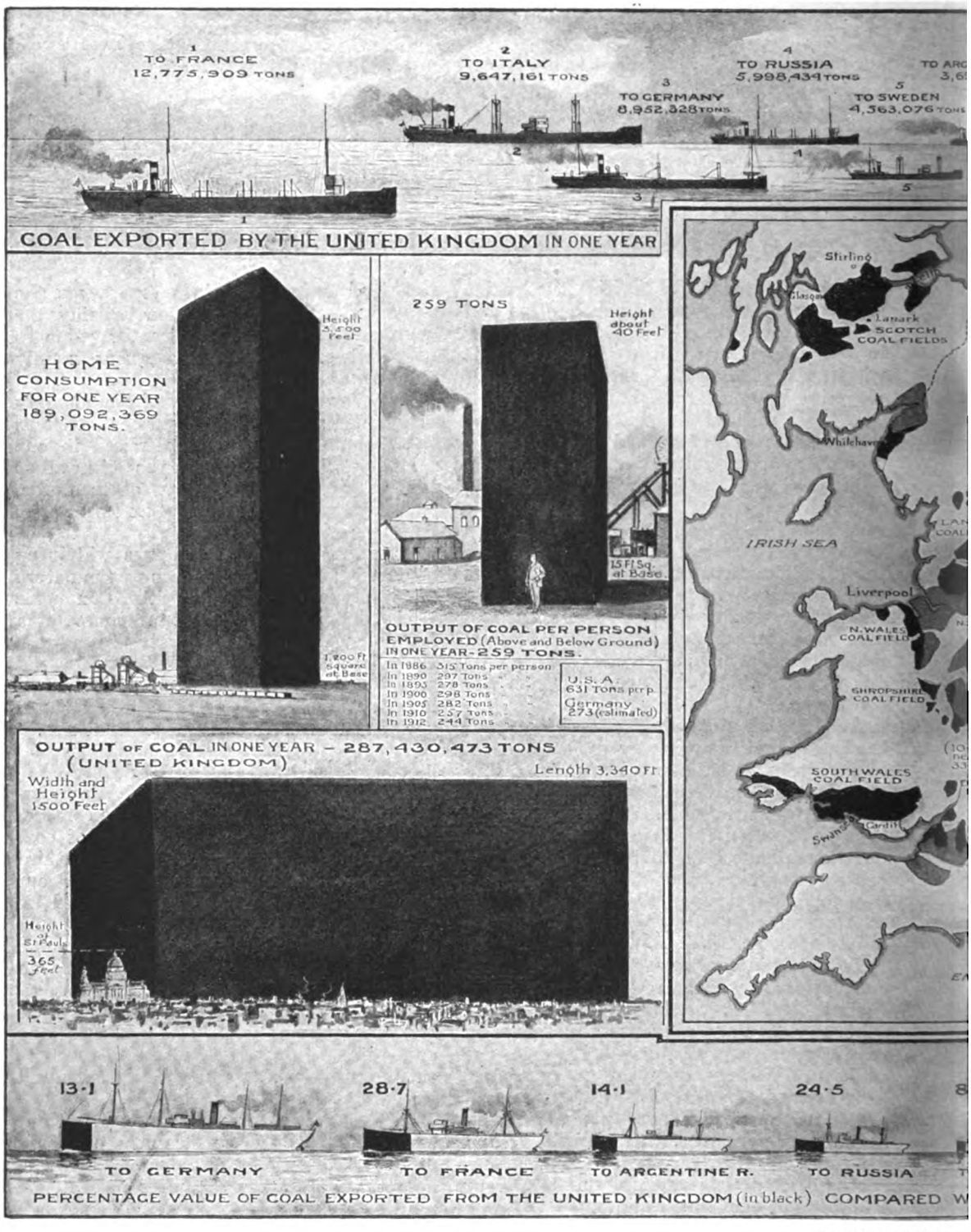
A realisation of these figures will bring home more closely than anything the nature of the economic problem British Commerce is called upon to face. In the course of a few years the price of coal at the pithead rose from 6s. 4d. per ton to 19s. 5½d. for the same amount, and there is not an individual industry that has not been affected to an amazing degree by this phenomenal rise.

The Vital Industry

As a matter of fact, thoroughly to understand the position, it will be well to consider just how the 189 millions of tons of coal consumed at home are used. One third of it goes to keep the machinery of our factories working and another third is used by the iron and steel industries and by the domestic fireplace. In other words, we burn 35 million tons of coal every year in our homes.

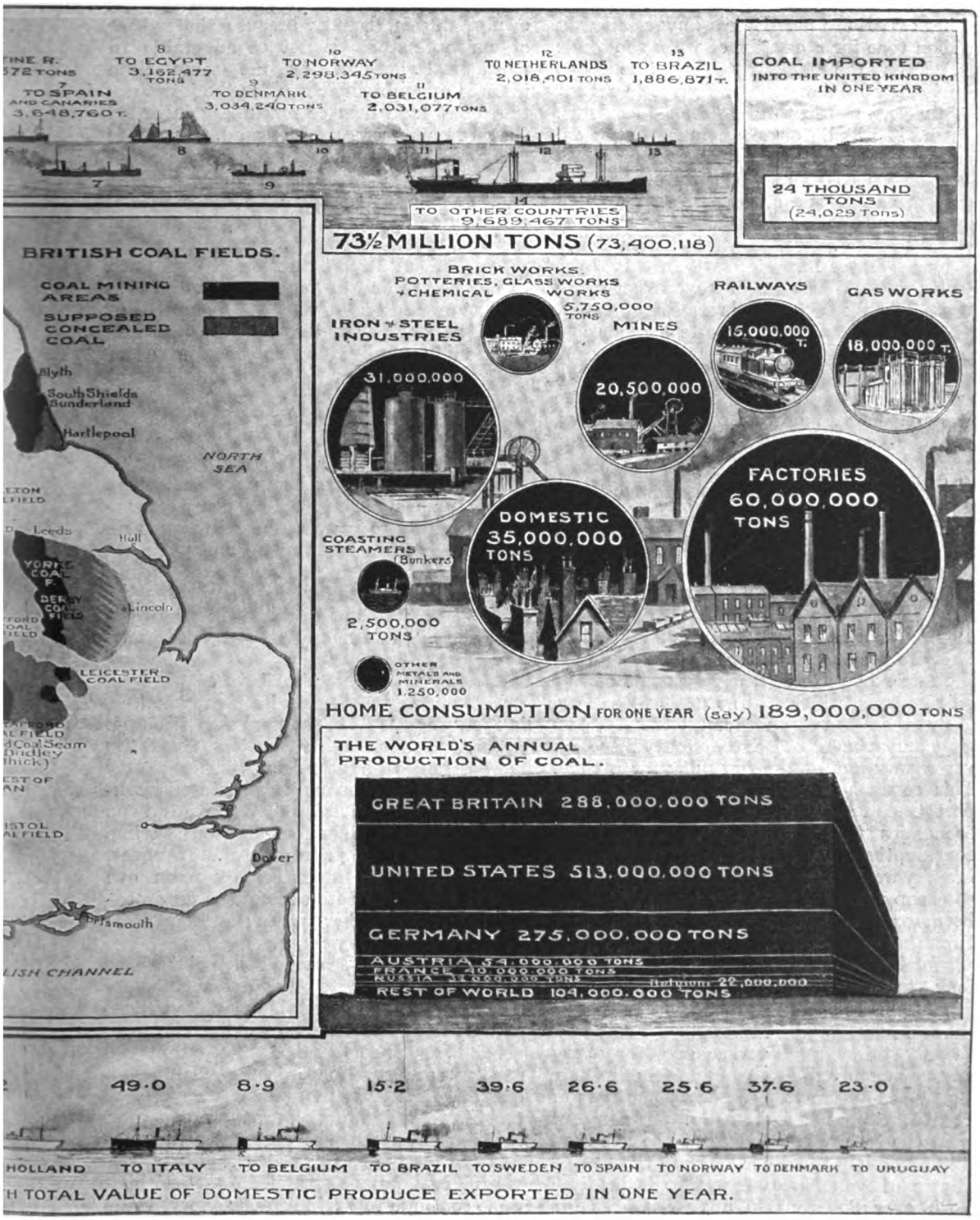
The remaining third of the total output for home consumption is used in the working of the mines themselves; in our gas works; on our railways; and in the potteries and glassworks.

Of the coal we send abroad we find our best customer in France, which can only produce annually 40 millions of tons from her own mines. As a matter of fact, we send to France more than 12 million tons a year, which pays for nearly a third of our imports from our neighbour. Italy takes nine million tons of coal in return for half the goods we buy from her. Germany buys nearly nine million tons for about 13 per cent,



"ENGLAND

The upheavals of war and changing industrial conditions have made our statistician's task very difficult. His idea of what Britain requires of those who work her coal mines during a year of normal trading under as coal-saving devices have been



EXPECTS . . . . "

figures, however, have a very good comparative value, and, as displayed above, give a very fair and general peace conditions. The output of coal demanded is essential to our commercial supremacy until such time perfected or substitutes tried and proved.

of her exports to us. Russia buys nearly six million tons for a quarter of what she sends us. Even the far-away Argentine buys nearly four million tons and gives in return 14 per cent. of the total goods she sends us.

Now it will be quite obvious that if we charge our foreign customers more than three times as much for their coal as we used to charge them we shall have to pay enhanced prices for every single commodity we take in exchange. But there is a factor of even greater importance than this to be considered. Whereas our coal exports are worth 50 millions of pounds sterling annually, the value of our total exports exceeds 500 millions, the bulk of which is represented by manufactured goods. With the worth of coal trebled, therefore, we have to charge proportionately more for our manufactures, and consequently must pay more for the raw material that we import.

Coal-saving Devices

We come, therefore, to the point when we must either agree to raising the financial standard in commerce or finding a cheaper fuel than coal. The former alternative in the markets of the world is, mainly on the score of our insular position and shipping, likely to prove derogatory to our commerce ; the latter consists of a development of our oil resources, which will be dealt with later.

But there is yet another alternative, possibly only a more or less temporary measure, yet a way out of the difficulty for a time. This consists in fully maintaining our export trade in coal and in bringing into play economies that would reduce our home consumption. Looking at the problem broadly we may say that coal has always been so cheap and so easy to hand that we have been extravagant and wasteful in its use. Now that we are brought face to face with economic disaster through dear coal we must look to clever inventors and industrial organisers to bring forward schemes for saving.

Only thirty years or so ago, for every person employed in our mines, both those below ground and those above, 315 tons of coal were produced annually. In a recent year the total was estimated to be less than 183 tons. On the other hand, in the United States of America each worker is credited with over 600 tons in a year, whilst the German miner is estimated to produce 273 tons annually.

Both in America and also in Germany coal-getting machinery is in use in the mines to a far greater extent than pertains in our own coalfields, largely because the nature of our coal seams is not so adaptable to mechanical hewing. At the same time there is undoubtedly room for the introduction of a good deal of machinery in order that output may be increased. There is also an opportunity to economise over transport and distribution, and there might well be eliminated some of the wasteful competition that only makes for high prices. Properly organised campaigns would ensure a more economical consumption of coal both in our homes and in our factories, and it is against our interests that the high price of exported coal should contribute towards cheapening supplies for home consumption.

The coal problem as it stands to-day is not one of supply. In the immediate neighbourhoods of each of our coal districts, with the exception perhaps of South Wales, there are concealed coalfields as large if not larger than those that are being worked. The coal is there, enough to last for many generations, waiting to be mined ; and there is no reason why for a great number of years we should not hold our position as the second coal-producing country in the world, with the United States of America the first by a long way, and Germany a good third to us.

Oil the Substitute ?

But whether coal holds its own, whether, in fact, we pass from the Coal Age itself, is dependent upon other matters than the mere deposits of the mineral. The greatly increased pay of the miners' shortened working hours, expensive improvements and the fixing of the individual output are the prime causes of the high price of coal. In effect, these movements press heavily upon our export trade (with its consequent reciprocation) ; upon all other trades ; and upon our domestic national welfare.

Whether we have reached the point where coal must give way to oil or not, remains to be seen ; but if oil can be marketed more cheaply than coal, then oil will have its way, particularly if it can be produced in the mother country. Motor spirit, lamp oil, gas oil, Diesel engine oil, lubricating oil, paraffin wax, and fuel oil are the products of coal, but they are also essentially the products of petroleum (*see* p. 121).

Will coal fail us ? Will its present high price continue to prejudice our export trade and consequently our national credit ? Will coal economically be ousted from its position by oil ? It is the greatest economical problem of the day, and one with which is bound up inseparably Britain's whole future.

Continued from page 80.

HISTORY:

***Contributors:*—J. A. Brendon, B.A. (Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A. (Oxon.); James A. Manson; L. Stampa, M.A. (Oxon.); and J. B. Sterndale-Bennett.**

ANCIENT ROME

(*Continued from page 80*)

THE year 215 B.C. saw the opening of the struggle between Rome and Macedon, which, under Philip V., had more than regained its old position of pre-eminence in Eastern Europe.

It was a long-drawn-out business, this war with the might of Macedon; and so complex were its political ramifications and countless side issues that details cannot be entered into here. It must suffice to say that by the end of the second century B.C. Rome had reduced not only the whole of the Balkan Peninsula, but, in accordance with that same dogged system of gradual absorption which was the secret of her territorial development, had brought all the western part of Asia Minor under her dominion. North of Italy, moreover, she had already begun to make her influence felt in Gaul beyond the Alps, and her world empire was almost an accomplished fact.

After-effects of War

But at home everything was by no means well. The conduct of war had become the chief business of State, and civil life had consequently suffered. The streets of Rome were filled with discharged soldiery who had plenty of money—the plunders of conquest—to spend, and who could neither be induced, nor, indeed, were suited, to resume a normal, peaceful life.

Corruption and bribery, licence and vice, were rampant everywhere. Rome, in fact, had committed the same error which Spain, during the days of her prosperity, committed later; and, instead of so ordering her conquered territories as to unite them to herself by ties of mutual interest and trust, she tended to exploit them merely as sources of revenue. Thus, although money poured into the city, trade and industry, which form the only true criterion of the material welfare of a State, were stagnant.

During the Punic Wars, moreover, Italy had been exhausted by the successes of Hannibal to such an extent that the bulk of the land had gone to fallow; whilst the government, in order to provide bread for the populace and allay the possibility of panic in Rome, had resorted to the expedient of purchasing grain from abroad and selling it at less than cost price.

This fatal practice made it impossible for the natives of Italy to grow corn at a profit, and, therefore, only increased agricultural depression; whilst the enormous importation of slaves into Italy, which followed the course of the subsequent wars, gave rise to entirely new industrial conditions and practically closed the market to free labour.

Labour Troubles

Social unrest and agrarian agitation were the inevitable sequels; and the condition of affairs rapidly became acute now that supreme authority had passed—in fact, if not in theory—into the hands of the Senate, a body of men who had no qualification for office save the possession of vast wealth, and whose one fixed purpose was to suppress and bleed the poor.

From time to time high-minded statesmen came forward—notably the brothers Gracchi—and strove bravely, if blindly, to combat the evils of the age. But the ruling class in Rome had no use for men of this type. Tiberius Gracchus was murdered; whilst his younger brother, Gaius Gracchus, although he succeeded in effecting many notable reforms, increased, rather than lessened, the gravity of the crisis.

In the first place, instead of raising the price of grain he reduced it still further, and so directly defeated his own object and intensified the economic problem. In the second place, instead of trying to reform the Senate he sought to control it by organising the opposition of the lower strata of society—a fatal policy, since the people of Rome at this time were so fickle, so sus-

ceptible to bribery, that it encouraged those very abuses it was intended to restrain.

The fact is, that Rome had outgrown her Constitution. The State needed more than reforming; it needed rebuilding. The task had passed beyond the power of lawyers. The Man was wanted—the Man and the Army.

The Man and—

The occasion produced both.

It all came about in this way. In 113 B.C. Rome found herself threatened by a new and unexpected danger. The Teutonic tribes of northern and central Germany began to move southwards in quest of more fertile settlements, and in 109 B.C. invaded the Valley of the Rhone, which was then a Roman province.

Time after time, moreover, they defeated the armies sent north to check their progress, and, sweeping on, carried all before them, until the Senate, at last thoroughly alarmed, reluctantly put prejudice aside and invited a man of plebeian origin—Marius, the most able soldier in the State—to take command of the forces.

In two brilliant campaigns, in 102 and 101 B.C., Marius utterly vanquished the Teuton hordes. Then he returned to Rome—with his army.

Now the Roman legions hitherto had been made up exclusively of yeomen farmers. But, owing to the land troubles, this class had decayed to such an extent that Marius, in order to raise the force which he required, was obliged to recruit from all sections of the community, and, in effect, brought into being a professional army in the place of the old militia.

—the Army

The latter had only included men entitled to the rights of Roman citizenship. The new army, on the other hand, having been drawn largely from the cities of the Italian Allies, was composed for the most part of men who had no voice in the general direction of Roman affairs, but who, now that they had saved Rome from disaster, claimed that privilege—and with reason—both for themselves and their fellows.

In the year 90 B.C., moreover, when the claim seemed still unlikely to be recognised, the Allies proceeded to enforce it at the point of the sword. The Social War, as it is called —i.e. the war of the Socii, or Allies—lasted two years, and ended in Rome conceding what was demanded of her, and granting the full franchise throughout Italy south of the Po.

This change definitely ended the existence of Rome as a city-state, and, further than that, marked the introduction into political life of an important new element—the army. And henceforth, until the final establishment of the Empire, the army held the sovereign power. Which party could command the army's support? Upon the answer to this question depended everything.

At first the army sided with the reactionary party, and, in obedience to the wishes of Sulla, a leader adored by all his soldiers, twice expelled the popular party from the city. On the second of these occasions, in 83 B.C., when Sulla returned to Rome after conducting a series of victorious campaigns in the East, it was generally expected that he would employ the army to establish himself as king.

But Sulla was not a revolutionary; at heart he was a proud Roman noble, a true child of the Republic. Having overthrown the popular party, therefore, and having restored and strengthened the power of the Senate, he retired, to the surprise of everyone, peacefully into private life.

Caius Julius Cæsar

Sulla, in fact, was not the Man. The Senate, however, even though fortified in its old position, was far too corrupt and degenerate to maintain the supremacy restored to it, or to control the destinies of Rome. Indeed, in handling the series of political problems with which it was faced during the years following Sulla's retirement, it again displayed its utter incompetence.

In Spain at this time a serious rebellion broke out, under the auspices of the popular party; whilst in Southern Italy the slaves and gladiators also rose in revolt. The Roman province of Asia, moreover, was threatened with invasion by the hosts of Mithridates, the warlike King of Pontus.

The Senate immediately put armies in the field to deal with those three crises, but in each case the efforts of the senatorial generals met with signal failure, until at last two young officers, who had both been lieutenants of Sulla—Gneius Pompeius, the scion of a noble Rome house, and P. Licinius Crassus, surnamed Dives, on account of his immense wealth—came forward and stamped out respectively the rebellions in Spain and Italy.

In 71 B.C. Pompey and Crassus returned to Rome, and demanded that they should be elected consuls. Seeing that neither of them had as yet held any magisterial position, their demand was strictly at variance with

the letter of the Constitution. But Pompey and Crassus each had an army behind him, and both men were duly elected for the ensuing year.

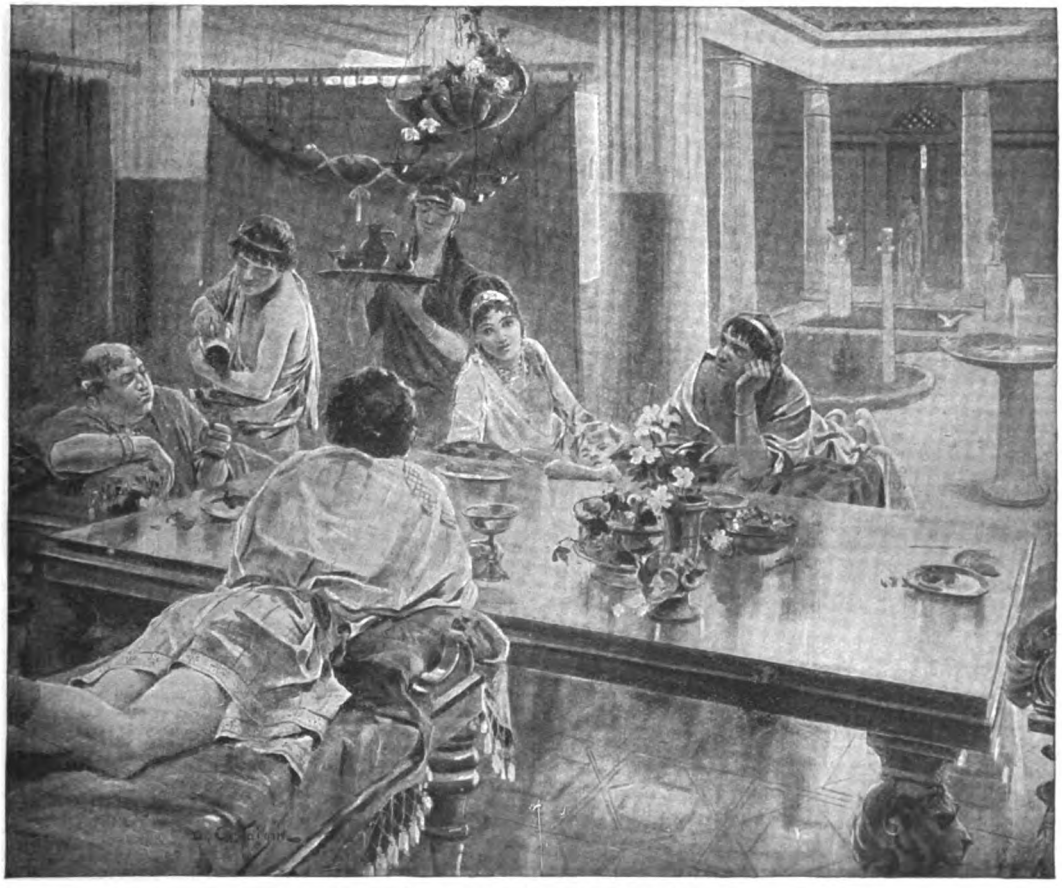
Three years later Pompey secured for himself the command of the army in the East, and sailed away to settle accounts with Mithridates. And not only did he successfully accomplish the task, but during the course of his campaign carried the Roman power to the banks of the Euphrates.

In Rome, meanwhile, the popular party, headed by Crassus, who had recently been joined by a rising young statesman of marked ability—one Caius Julius Cæsar—was strenuously striving further to curtail the weakening powers of the Senate. But the issue of this struggle must, as everyone realised, remain in doubt pending the return of Pompey, for Pompey had the army, and with the army lay the last word in all matters respecting the public weal.

In 61 B.C. Pompey returned; and after a few weeks of hesitation, finally threw in his lot with Crassus and Cæsar. The three men, in fact, over-ruled the Constitution, formed themselves into what is known as the First Triumvirate, and assumed supreme authority—an authority which none could resist, for Cæsar was the idol of the people, Crassus the richest man in all the State; while Pompey had won for himself a military reputation such as no Roman soldier ever before had held. And on this account Pompey was stronger than Crassus and Cæsar combined.

But in 58 B.C. Cæsar usurped Pompey's position by getting himself appointed Proconsul of Gaul, and so assuming command of an army.

From 58 to 49 B.C. Cæsar was absent from Rome, steadily extending the boundaries of his province and carrying the fear of Rome even into the heart of Britain. But all the



THE FRUIT OF SUCCESSFUL WAR.

A well-to-do merchant, a "profiteer" of Imperial Rome, at dinner.

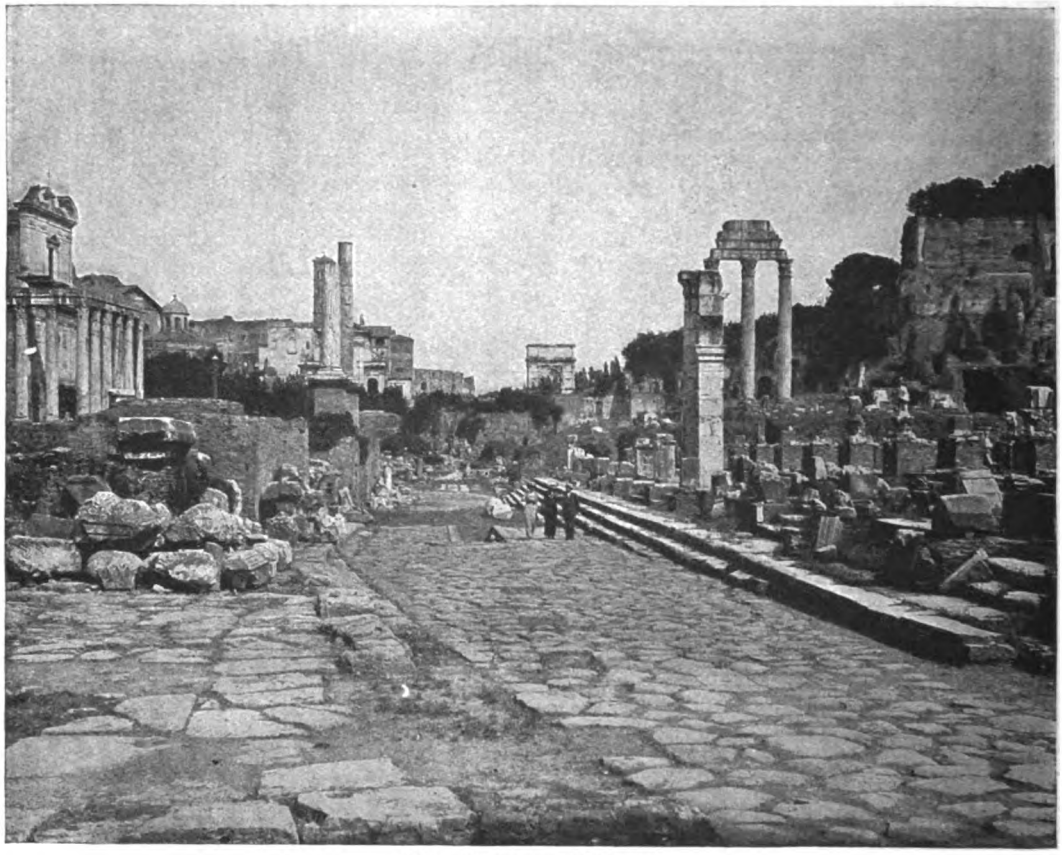
while, by means of an elaborate secret service, he kept himself closely in touch with affairs in the capital, and patiently waited for his opportunity, the opportunity which he knew would come.

As no doubt Cæsar had foreseen, Pompey and Crassus, when left in joint charge of affairs in Rome, soon fell out. Each man regarded the other with suspicion, and both were gravely apprehensive as to the intentions of their colleague in Gaul—especially Pompey, who, after the death of Crassus in 53 B.C., became firmly convinced (and probably rightly) that Cæsar's one fixed purpose was to oust him from office.

Pompey, therefore, in order to safeguard his own interests, gradually detached himself from the cause of the people, and began so strongly to lend his support to the Senatorial party in opposition to Cæsar, that the latter realised in 49 B.C. that the time at last had come for him to strike.

On January 10th Cæsar crossed the Rubicon—the river which formed the northern frontier of Italy—proclaimed Pompey an enemy of the State, and then advanced on Rome at the head of his legions.

Before the approach of the victorious army of Gaul, Pompey and the Senatorial party fled in panic, and in August, 48 B.C., were finally overthrown by Cæsar at the battle of Pharsalia in Thessaly.



THE HUB OF EMPIRE.

Looking towards the Arch of Titus, a general view of the Roman Forum which was at once the Westminster and Piccadilly Circus of the only Empire that has rivalled ours.

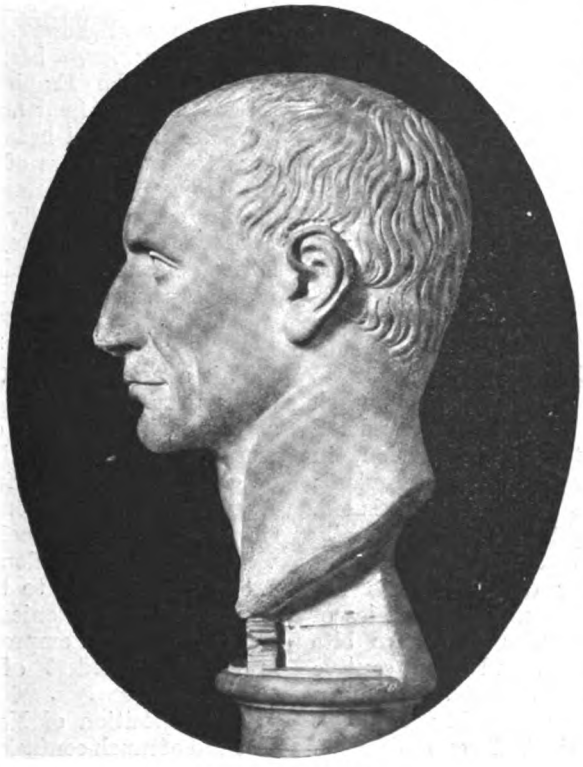
Some three and a half years later, having in the meanwhile stamped out rebellions in Spain and in the East, Cæsar returned to Rome, where he immediately assumed the title of Dictator. But Cæsar did not intend that his dictatorship should endure only for a limited period; he insisted on being appointed Dictator for life, and, as supreme ruler of the Roman world, set about to rebuild the State in accordance with his own conceptions.

Now, in this new State there was to be none of that division of sovereign power

which had been an endless source of dissatisfaction and weakness in the old State; there was to be one power above all other powers, and that power was to be the power of the sword as wielded by Cæsar, the only fount of justice and authority.

The Senate was to remain, but only as an instrument of administration in Cæsar's hands; the Assembly of the People was to remain, but only in order to register the will of Cæsar. All the old magistracies, and so forth, were also to remain, but they were to be placed directly under the control of Cæsar.

By one comprehensive stroke, in fact, Cæsar converted Rome from a Republic into a great military Monarchy; then, by another stroke, from a Monarchy into an Empire. In future—so he decreed—the rights of citizenship should be accorded not only to Romans and Italians, but to freemen throughout the Roman dominions, so that all might be bound together by a common fellowship and by a common allegiance to one sovereign power — to Cæsar.



JULIUS CÆSAR.

From the bust in the British Museum.

Thus, for example, in the middle of the first century A.D. we find St. Paul, a Jew born at Tarsus in Cilicia, claiming privileges which but a century or so before belonged only to free-born natives of Rome, and being readily granted those privileges by provincial magistrates.

But Cæsar did not live to see the franchise extended so far as this. Indeed, barely one year after his great imperial work began, he fell the victim of a foul conspiracy, and in 44 B.C., on "the Ides of March"—i.e. the 15th of that month—was murdered in the Senate House.

Yet, though Cæsar was dead, the restoration of the Republic was out of the question. The work which Cæsar had done could not be undone; it remained only for somebody to carry it on and bring it to completion.

But who was that somebody to be?

In his will the great Dictator had nominated as his heir his nephew, Octavian—a lad, nineteen years of age, whose mettle had yet to be tested. On hearing of Cæsar's death, Octavian, who was in Macedonia at the time, hastened immediately to Rome, there only to find that one of his uncle's old lieutenants, Marcus Antonius—or Mark Antony, as he is more commonly known—had placed himself at the head of the State and seized the sovereign power.

Civil war, therefore, again broke out in Rome, but Octavian, who was above all things an eminently tactful lad, succeeded eventually in coming to terms with Antony; and in October, 43 B.C., he, Antony, and Lepidus, the then Proconsul of Gaul, formed themselves into the Second Triumvirate. Lepidus, however, was soon turned adrift by his colleagues, who proceeded then to divide the management of the Roman dominions between themselves, Antony taking the eastern, Octavian the western provinces.

Now Antony, in common with many of the strong men who have played prominent parts in the history of the world, was very susceptible to the charms of women; and during his sojourn in the East he fell under the spell of Cleopatra, the Queen of Egypt, who at one time had entoiled Julius Cæsar himself in the meshes of her fascination.

Acting under the influence of this beautiful but dangerous woman, Antony, in 32 B.C., declared war on Octavian, with results disastrous to himself, for in the following year, at the great battle of Actium, he was totally

defeated by Octavian, who now, at the age of thirty-two, found himself master of Rome and all her territories, and assumed the proud title of Imperator and the still prouder title of Augustus.

Cleopatra, when she realised the dramatic finality of Antony's downfall, shut herself up in the gorgeous mausoleum which had been prepared to receive her body after death; and, fearful of the wrath of the lover whose misfortune she had brought about, she caused to be spread abroad the report that she was dead.

Death of Cleopatra

Antony, when these tidings reached his ears, was overwhelmed with grief, and true to his passionate, impulsive nature, stabbed himself—only then to learn that Cleopatra still lived. Mortally wounded, he gave orders that his attendants should carry him to her, was raised by ropes into the mausoleum, and there he died—in the arms of his mistress.

Cleopatra then surrendered herself to Octavian. But she merely feigned submission. Too proud to allow herself to grace the splendour of Octavian's triumph through the streets of Rome, she surrendered voluntarily merely to allay suspicion, in order that the vigilance of Octavian's guard over her might be somewhat relaxed, in order that she might be able more easily to compass her own death.

The manner of her death remains unknown; it is one of the minor mysteries of history. Legend attributes it to the bite of an asp which was conveyed to the captive queen in a bowl of fruit. But all that can be said with certainty concerning it is that Octavian, much perturbed one day at receiving from Cleopatra a missive begging that she might be buried by the side of Antony, hastened to his captive, whom he found, arrayed in all her royal apparel, dead, and Iras and Charmion, her two faithful handmaidens, dead beside her.

Imperial Rome

The Roman Empire had now become an accomplished fact—the Empire which, in name at any rate, endured till 1806, when Francis II., the last of the Emperors, unable to withstand the domination of Napoleon, abandoned the title of Roman Emperor, and became instead Francis I., Emperor of Austria.

"During my sixth and seventh consulship," Octavian declared, "when I brought the civil wars to an end, and was by the consent of all master of the State and its resources, I entrusted the Republic to the Senate and the People for them to do as they liked with it. . . .

"In return for this service the Senate decreed me the name Augustus. Thenceforth I enjoyed a higher dignity than any other citizen, yet I had no more official power than my colleagues in the various magistracies I held."

No more official power—perhaps. But, none the less, very much more power, for Augustus, like his successors, held absolute command of the army; and, however elaborate and however gratifying to the people may have been the constitutional features of the Empire, the army was in all matters the final and supreme tribunal.

We cannot deal here at any great length with the early years of the Empire, though the story of how Roman law and Greek culture came gradually to be spread to the remotest corners of Europe, to Asia and to Africa, is one to which the student might profitably turn at some future date.

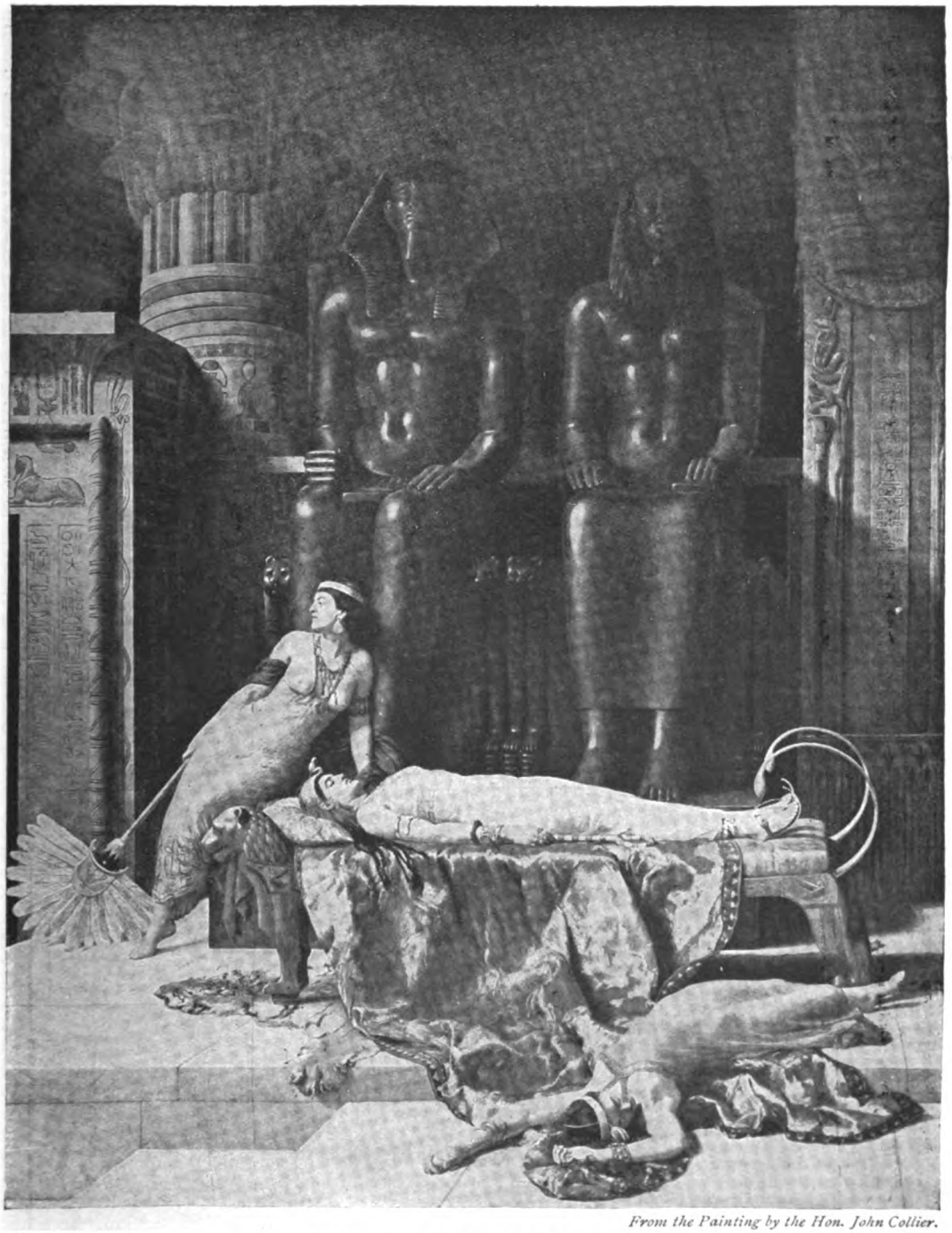
Christian Persecutions

It is a profoundly interesting story; and the reader will find much to absorb his attention in the lives of the Emperors in whose hands at this time rested the reins of government: Tiberius—the successor of Augustus, and the contemporary of Jesus Christ—a clever, far-seeing monarch, shrewd, vicious, and unscrupulous; Caligula, his heir, a boy who drained to the dregs the cup of power and was intoxicated by it; Claudius, the tool of artful empresses; and Nero, the last and wickedest of all the House of Cæsar.

The deposition of Nero was followed by a period of much confusion in Rome, emperors being set up one after another and overthrown like ninepins, until at last, in A.D. 70, Vespasian assumed control of the ship of State and Rome again enjoyed a stable government. It was during the reign of Vespasian's son, Domitian, that Britain was finally conquered; and under Domitian's successors — the great Emperors Nerva, Trajan, Hadrian, Antonius Pius, and Marcus Aurelius—that the Imperial office rose to its greatest splendour.

There is in the popular mind a dangerous tendency to regard all the pagan Roman emperors as bad, naughty men. In some cases, it must be admitted, the description is justified, but by no means in all.

We regard these Emperors as bad mainly because the early Christian Church condemned them for persecuting Christians. This persecution, however, is quite intelligible,



From the Painting by the Hon. John Collier.

THE DEATH OF CLEOPATRA.

The beautiful Queen of Egypt, who, after the death of Mark Antony, her lover, committed suicide rather than grace the "Triumph" through the streets of Rome of Octavian, Antony's rival. Tradition attributes her death (30 B.C.) to the bite of an asp, which was conveyed to the captive Queen in a bowl of fruit.

and, from the point of view of the Emperors, was not merely justified, but necessary.

The Romans, as a matter of fact, like most polytheistic people, were very tolerant and broad-minded in religious matters. Having many gods peculiar to themselves, they were quite prepared to admit that each of the various races composing the Empire was entitled to gods of its own, provided that—and this was quite easy to a pagan people—due reverence was paid to the sacred person of the Emperor and to the Sun, which the Romans chose to regard as the celestial symbol of Imperial unity.

Now the early Christians, of course, could not make the required obeisance either to the Emperor or to the Sun; they insisted on honouring the One God, and so inevitably came to be suspected of disloyalty to the Emperor. Exigencies of State, therefore, demanded their persecution.

It was not until some time later, when the Greek part of the Roman world had become Christian and the Papacy firmly established, that the Emperors conceived of the great notion of going, as it were, into partnership with the Popes and completing the latter's functions as God's spiritual viceroys on Earth by constituting themselves as His temporal viceroys and, as the heads of a Holy Roman Empire, unsheathing their swords in the cause of Christianity.

Constantine the Great, who came into power in A.D. 306, was the first of the Christian Emperors. Prior to his accession, however, the dominions to which he succeeded went through a very curious phase.

To control Asiatics and Europeans under one common authority is a task calling for superlative statesmanship; and in the Roman Empire so acute did this problem become, and so urgent the question of frontier defence, that in A.D. 284 it was decided to establish two Emperors who should be joint sources of rule, the one controlling the East, the other the West.

But the remedy, so far from relieving, only made worse the malady it was intended to cure; and Constantine ended this unsatisfactory system of dual control.

The Roman Empire again stood united. But since it was in the East that danger pressed hardest, Constantine thither transferred the seat of his government, choosing for his capital the Greek city of Byzantium, which soon became known as Constantinople, and remained the centre of Latin rule and civilisation in Eastern Europe until 1453, when it fell into the hands of the Turks.

With the establishment of Constantinople, Rome ceased to be the heart of the great Empire of the ancient world; but she did not lose her importance, for springing up within her was a power which was destined to prove even greater than that of the Cæsars—the power of the Papacy. J. A. B.

Map showing the greatest extent of the Roman Empire.

Continued from page 97.

SCIENCES:

Contributors:—ANTHROPOLOGY AND ETHNOLOGY (Sir H. H. Johnston, G.C.M.G., K.C.B.). ASTRONOMY (Arthur R. Hinks, M.A., F.R.S.). BOTANY (E. W. Edmunds, M.A., B.Sc.[Lond.]). CHEMISTRY (E. H. Tripp, Ph.D.). ELECTRICITY AND MAGNETISM (L. M. Parsons, M.Sc., D.I.C., F.G.S.). GEOLOGY AND MINERALOGY (Arthur Holmes, D.Sc.[Lond.], A.R.C.S., D.I.C., F.G.S.). PHYSIOLOGY (Sir Malcolm Morris, K.C.V.O., and D. W. Carmalt-Jones, M.A., M.D.[Oxon.]). SOUND, LIGHT, AND HEAT (E. W. Edmunds, M.A., B.Sc.[Lond.]). ZOOLOGY (E. A. Bryant and Ashley G. Brown, F.Z.S.).

CHEMISTRY.—III

FROM the very earliest times down to the end of the eighteenth century, the ignorance of mankind concerning the nature of combustion, one of the most familiar of all phenomena, was profound and complete. To the great Frenchman Lavoisier (1743–94) belongs the honour of having enlightened the world on this subject, and since his time there has never been any doubt as to the true explanation, albeit chemists are still working to-day to elaborate the details and to give the finishing touches to the illuminating conceptions of that great master.

Before the time of Lavoisier the generally accepted explanation was that every combustible substance contained a fiery principle, termed "phlogiston," which escaped when the combustion took place; and the more phlogiston a substance contained, the better did it burn.

The systematic application of the balance was the chief factor in the refutation of this doctrine. If anything escaped during combustion, the burnt material or calx should weigh less than the original substance: but accurate observations demonstrated that when anything was burnt in such a way that no gases or fumes were allowed to escape, not only was there no reduction in weight, but in every case a decided gain in weight could be detected. Such experiments can be readily performed by the beginner.

Experiment VII.—*To find out how magnesium changes when it is burnt.*

A small crucible with its lid is heated in the Bunsen flame, cooled and then weighed. A strip of magnesium ribbon, about 26 cm. long, is also carefully weighed, twisted up in the form of a loose ball and placed in the crucible. The latter is placed on a pipeclay triangle, which is supported on a tripod stand, and gradually heated to a high temperature with the lid on. On removing the flame, and taking off the lid with a pair of crucible tongs, the ribbon may burst into flame. If it does, the lid must be replaced immediately in order to prevent the escape of the white fumes. If no combustion takes place, the crucible must be further heated until the requisite "temperature of ignition" is attained. On replacing the lid, the combustion at once ceases. (What conclusion can be drawn from this?) The flame is applied again, removed, the crucible uncovered, and then immediately closed. These operations are repeated until on withdrawing the lid no further combustion ensues. The crucible is then strongly heated for about five minutes with the lid off. After cooling it is weighed. The weighings should be entered as follows:—

1. Weight of crucible and lid	14·574 g.
2. Weight of magnesium	0·260 g.
Weight of crucible, lid and magnesium	14·834 g.
3. Weight of crucible, lid and burnt magnesium	15·004 g.
Weight of crucible, lid and unburnt magnesium	14·834 g.
Gain	0·170 g.

All exercises similar to this should be recorded in a similar manner, the weighings being clearly entered, the subtractions shown, and the wording made as clear and concise as possible.

From the fact that magnesium gains in weight when it is burnt, we draw the conclusion that it must have combined with something. The ash or scale produced is seen to be a dull, grey powder: further, it is amorphous, i.e. not crystalline, the particles having no regular, uniform shape. The dark colour of the ash is due to the manner of combustion: when pure it is quite white.

This scale, sometimes called magnesia, is one of the most refractory substances known. The fiercest heat has no effect upon it: hence it is used in making crucibles and bricks for lining furnaces.

To calculate the gain in weight on one gram of metal:

0·260 g. of magnesium gained 0·170 g.

$\therefore$ 1 g. of magnesium would gain $\frac{0{\cdot}170}{0{\cdot}260} = 0{\cdot}65$ g.

We shall require this result later.

Experiment VIII.—*To find out how copper alters when it is burnt.*

This experiment is carried out in a manner very similar to the preceding, but as the copper does not actually catch fire, there is no need to use the crucible lid. The metal should be in such a form that it offers a large surface, i.e. in the form of "turnings" or filings, and if these are greasy they must be previously washed with ether. In from ten to fifteen minutes over a hot flame the surface of the copper will be completely coated with a dull, black, amorphous scale. An increase in weight will be observed, showing that this metal also combines with "something from somewhere" when burnt.

Other metals may be heated in a similar way. Iron, zinc, and lead are all suitable, but for the first named a very high temperature is essential, and in the absence of a muffle-furnace, a Teclu or a Mékar burner must be used. The iron scale obtained is dull, black and amorphous; it is identical with the "smithy scale" of the blacksmith's shop.

The zinc may catch fire and burn with a bright greenish flame; in this case a crucible lid must be used. The scale is greenish-yellow and incandescent when hot, but white and dull when cold. It is much used as a white paint, "zinc white," and as the chief constituent of zinc ointment.

Lead scale combines with the porcelain of the crucible to form a yellow glaze, so to obtain it pure the metal must be heated on an iron plate. Lead melts quickly and becomes covered with a scale or dross, called litharge, which has a dirty dark-brown colour when hot, but is reddish-yellow, also dull and amorphous, when cold. It is used as a glaze for pottery, in the manufacture of certain kinds of glass, and as a "filler" for rubber tyres. If litharge be heated for many hours at a dull red heat, it gains in weight and is converted into "red lead," a bright red, amorphous powder used as a paint for iron work, for mixing with putty and in glass manufacture.

Even the liquid metal, mercury, can be burnt. The operation is a very slow one and takes several days. Mercury scale is a bright red powder, used as a paint for pillar-boxes, and for the bottoms of ships.

Careful experiments show that all the metals mentioned above increase in weight on combustion. Of the better known metals, only gold, platinum, and silver defy all efforts to burn them.

Substances like metals are comparatively easy to experiment with because they yield only one product of combustion, and that a solid one; but if we wish to find out if there is a gain in weight when such materials as sulphur, charcoal, a candle, and oil are burnt, the problem is more difficult, because the products are gaseous.

Experiment IX.—*To find out if the products of combustion of a candle weigh more than the wax burnt.*

When a candle is burnt it disappears because the wax is converted into two colourless gases which escape into the air. It is necessary to retain these gases in order that they may be weighed. This is effected by means of caustic soda or caustic potash, with which the gaseous products readily combine. A lamp-chimney is inverted, and upon a small piece of wire-gauze fixed in the lower part some lumps of quicklime are placed, and upon these small sticks of caustic soda. The object of the lime is partly to prevent the heat from melting the soda and partly to help fix the gases. The chimney and contents are hung from the arm of a large ("demonstration") balance directly over a piece of candle fixed on to the balance pan below; and the whole is counterpoised. On lighting the candle a mist appears on the inside of the glass, but as the latter gets hot it soon disappears. After a few minutes the flame is extinguished, when some fumes of unburnt wax escape. On cooling, the beam is again raised, and a considerable gain in weight is noted. Therefore the gases produced by the combustion of the candle weigh more than the part of the candle consumed.

Experiment X. — *Does phosphorus gain in weight when it is burnt?*

On account of the ease with which it takes fire, and because it is self-luminous in the dark, phosphorus was at one time regarded as a wonder of Nature. Its ready inflammability makes it a very convenient material for elementary experiments, but at the same time this property makes it dangerous to work with.

Phosphorus is always kept under water: it should never be handled. When it is burnt it emits much light and heat, forming a white powder which dissolves in water with a hissing noise, owing to the heat set free.

A piece of hard glass tubing, about 15 cm. long, drawn out slightly at one end, is packed with asbestos-wool, a small piece of phosphorus is then inserted and then a little more asbestos; the tube is then supported by a clamp attached to a retort-stand.

Asbestos is a mineral which is quite unaffected by heat: in this experiment it is used to prevent the solid particles of phosphorus scale leaving the tube.

To ensure the phosphorus being properly burnt, a current of air must be sent through the tube. The simplest method of doing this is to connect the narrow end of the tube to a large bottle fitted up as a siphon.

When the water runs out of this bottle, air comes in through the hard glass tube to take its place. The tube, with the phosphorus in it, is weighed, and then a small flame is applied to that part of it where the phosphorus is situated. The phosphorus melts and then burns, the white fumes being caught on the asbestos. Very few of these fumes will escape into the bottle if the asbestos has been properly packed. Some of the phosphorus will be left over—as "red phosphorus." This may be burnt if desirable by using a hotter flame and increasing the current of air.

After cooling, the tube is weighed again; a decided gain in weight is observed.

The above experiments will suffice to establish the general truth, or law, that the products of combustion of a substance weigh more than the substance itself. We must now inquire as to the cause of this phenomenon.

It is a common experience that a bicycle lamp, the holes of which have become clogged by dirt or soot, fails to burn: that a fire burns better when it is given a liberal draught of air. Further, in the magnesium experiment, no combustion took place until the crucible lid was removed.

These observations point to the conclusion that air is necessary to combustion.

If a lighted candle be put in a closed bottle, it soon goes out, and the air left over no longer supports combustion. (*This experiment can be easily devised by the student.*)

Experiment XI.—*Can it be, then, that burning substances gain in weight because they take up something from the air?*

Remembering Experiment II. on the rusting of iron, we will burn a candle or some phosphorus in an enclosed volume of air over water, and see if the latter rises.

As soon as the flame goes out, the water rises rapidly and fills about one-fifth of the vessel: on plunging a light into the residual air, the flame is immediately extinguished.

These facts indicate that the burning substance combined with the oxygen of the air, and left the nitrogen intact. We thus see that burning is a process very similar to rusting, albeit much quicker and more apparent to the eye.

In every act of ordinary combustion, the combustible substance unites with atmospheric oxygen. The scale or product of combustion must therefore consist of the substance burnt together with oxygen: its chemical name is *oxide;* thus copper scale is copper oxide, litharge is lead oxide, the white fumes from burning phosphorus, phosphoric oxide, and so on.

Experiment XII.—*To find the relative proportions of oxygen and nitrogen in the air.*

A bell-jar, provided with a stopper, is divided into six equal divisions by means of five strips of label. It is then stood in a trough containing water, so that the level of the latter is the same as the lowest mark, when the bell-jar is open. Thus there are five parts of air left. A small piece of phosphorus, dried by gently pressing it between filter-paper, is placed on a dry crucible lid supported on a stand. After ignition with a heated knife, it is covered with the bell-jar and the stopper is inserted.

The water in the bell-jar is first observed to sink, owing to the heat given out by the combustion causing the air to expand; it then rises and continues rising until the temperature has sunk to the normal. Water is then poured into the trough until its level is the same inside and outside the jar. The water now stands at the second division, showing that one-fifth of the air has disappeared. When the white fumes of phosphoric oxide have completely dissolved a light is introduced; it is at once extinguished, showing that the residual gas is nitrogen.

Therefore the proportion of oxygen to nitrogen in the air is approximately 1 : 4.

Experiment XIII.—*To find out if there is any change in weight when phosphorus is burnt in a closed vessel.*

In a 500 cc. round-bottomed flask is placed a very little dry sand, and upon it a small piece of dry phosphorus. A tightly fitting cork or rubber bung is then inserted and by means of wire firmly secured in position. The apparatus is weighed or counterpoised on a balance. It is then fixed on a retort-stand and a small flame moved about slowly under the spot where the sand and phosphorus are situated. The phosphorus burns and goes out. When cool, it is again placed on the balance. The weight is the same as before, thus reminding us of the result of Experiment VI. on the rusting of iron. In the present case the phosphorus gains in weight because it unites with the oxygen present, but as the air loses this oxygen, the total weight of phosphorus and oxygen together remains the same.

The two experiments illustrate the very important principle called the Law of the Indestructibility of Matter (Conservation of Matter), which states that *matter can neither be created nor destroyed*, its form only can be changed. E. H. T.

TWO EMINENT FRENCH CHEMISTS

Lavoisier (1743-94) and Berthollet (1748-1822). The former, who perished by the guillotine during the Revolution, established the principle of the conservation of matter; the latter, who survived the Revolution—to be honoured by Napoleon and raised to the peerage by Louis XVIII.—established the principle of chemical equilibrium.

HEAT.—II

6. Construction of a Thermometer.—*A thermometer is an instrument for the accurate measurement of temperature.* We have seen that the indications of our sense of touch are vague and even misleading; in a thermometer we overcome these disadvantages by measuring change of temperature by means of another phenomenon which usually accompanies it, namely expansion or contraction.

The substance commonly employed for ordinary purposes is the liquid, mercury.

What we really observe in a thermometer is the change in volume of the liquid in it, and we assume that equal increments in the volume of the liquid correspond to equal rises of temperature. More advanced work on absolute temperatures has justified us in doing this.

In order to make a thermometer, a capillary tube of as nearly as possible uniform bore (§ 10) must be taken and a small bulb blown on one end (Fig. 8, A). If the attempt is made to pour liquid into this tube it will be found to be impossible on account of the smallness of the bore. The bulb is therefore carefully heated in the bunsen flame for a minute or so, and the open end of the tube promptly inserted into a dish of mercury (Fig. 8, B). As the air left in the bulb cools, its pressure is reduced, and some mercury is forced up the tube by the pressure of the atmosphere.

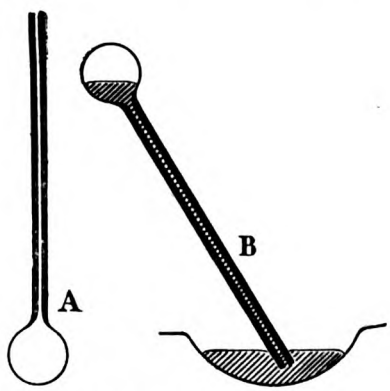


Fig. 8.—Making a Thermometer.

The bulb may in this way become half-filled with the mercury. The tube is then removed, and the bulb again carefully heated until the mercury inside it boils. The mercury vapour thus produced displaces the remainder of the air in the bulb and tube, so that when the open end of the tube is inserted in the dish enough mercury is forced in to fill the bulb completely; otherwise, the condensation of the mercury vapour as it cools would leave a vacuum in the bulb.

If a small bubble of air still remains in the bulb, the process must be repeated again and again until it is expelled. Finally, the whole instrument must be carefully heated until the mercury reaches the top of the tube, and the open end then closed with a blowpipe. No air will then be enclosed with the mercury.

EXPERIMENT.—The method of filling a thermometer can be easily illustrated by using methylated spirits (coloured with a trace of cochineal or other dye) instead of mercury. It is an experiment which the student should on no account neglect.

7. The Fixed Points on the Thermometer.—All our measurements—of length, weight, etc.—are made in terms of standards or units arbitrarily chosen; the requirements made of such units being that they should be convenient, definite, and easily reproducible.

Now the temperatures of melting ice and boiling water are, unless the pressure is changed, of this character; they therefore serve as standard temperatures in fixing a thermometric scale of measurement. The fixed points on our thermometer are therefore the freezing-point of pure water, and the boiling-point of pure water, both being taken at the standard pressure of 760 mm. (29·9. in.) of mercury (as indicated by a barometer).

Fig. 9.—Fixing Freezing-point.

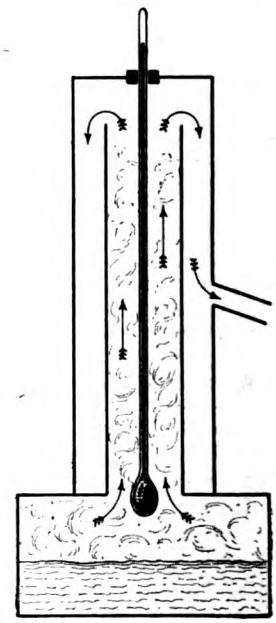


Fig. 10.—Fixing Boiling-point.

GRADUATING A THERMOMETER.

(1) To obtain the *freezing-point*, fill a funnel with small pieces of ice and insert among the pieces the bulb and part of the stem of the thermometer. When the ice begins to melt, it will be noticed that the mercury in the tube ceases to fall; having observed that it has become stationary, the observer marks the tube with a file at that point and has obtained the freezing-point. (Fig. 9.)

The ice in this experiment should be well washed before commencing, as the influence of slight im-

purities upon the freezing-point is often considerable. On the other hand, such changes of pressure as occur in the atmosphere from day to day do not produce sufficient effect to be recognised in ordinary thermometers.

(2) The *boiling-point* is obtained by inserting the whole thermometer in the steam arising from boiling water. The apparatus usually employed is a metal vessel, as represented in Fig. 10. The thermometer should be so arranged that the mercury just shows above the cork when it has attained its stationary level, which takes place several minutes after boiling has commenced. A correction has to be made for the variation due to the deviation of the pressure from the standard of 760 mm., and the water used must be free from impurities.

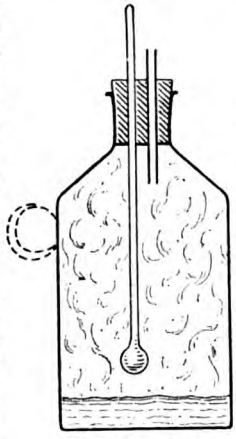


Fig. 11.—Testing Boiling-Point.

EXPERIMENTS.—1. Test the freezing-point of a thermometer as described above, and examine the effect on it of, first, a small quantity and then a large quantity of salt added to the ice.

2. Test the boiling-point of a thermometer. Use for the purpose a workman's tin can (Fig. 11), provided with a two-holed cork—one hole being for the thermometer, and the other for the escape of the steam. Examine the effect of salt, as in 1. Also compare the results obtained when the bulb is (*a*) in the boiling water itself; (*b*) kept an inch above its surface.

8. Thermometric Scales.—The interval between the fixed points is next divided into a number of equal divisions or *degrees*, and a scale of temperature is thus obtained.

Two scales are in common use.

The *Centigrade scale*, which is universally employed in scientific work and will always be implied in these lessons unless the contrary is definitely stated, has the fixed interval divided into 100 degrees, the freezing-point being called 0° and the boiling-point 100°.

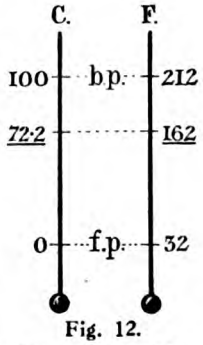


Fig. 12.
THERMOMETRIC SCALES.
Showing Boiling and Freezing Points—Centigrade and Fahrenheit.

Below the freezing-point the divisions are referred to with a minus sign, and they are carried also beyond the boiling-point. Thus − 20° C. represents a temperature of 20 Centigrade degrees below the freezing-point, and 120° C. represents 20 such degrees above the boiling-point.

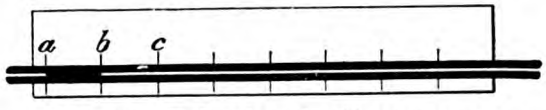


Fig. 13.—Calibration of a Thermometer.

On the *Fahrenheit scale*, familiar in the thermometers of everyday life, the freezing-point is called 32° and the boiling-point 212°. These numbers are the result of a false choice of standards by the originator of the scale. He thought that a mixture of ice and salt produced the lowest degree of cold attainable, and that such degree was consequently the true zero of temperature. We shall see later on that the absolute zero is much lower than this. His upper standard he took as the temperature of the interior of the mouth of a healthy man; this temperature he called 96° (it is really nearer to 99°), and on the scale thus defined the freezing-point was 32°. Extending it by equal degrees the boiling-point came to 212°.

In Germany the *scale of Réaumur*, with the freezing-point 0° and the boiling-point 80°, is sometimes used.

Though Fahrenheit's scale is not often used in science, it is convenient to be able to change its readings into the corresponding Centigrade readings, and vice versa. This is a simple arithmetical operation which an example will make clear.

1.—CONVERT 162° F. into C.

The space between f.p. and b.p. is the same in the two cases.

Hence 180° F. are equivalent to 100° C.

But 162° F. = 162 − 32 = 130° F. above f.p.

$\therefore$ since 1° F. is equivalent to $\frac{100^\circ}{180}$ C.

130° F. is equivalent to $\frac{100 \times 130^\circ}{180}$ C.

$= 72{\cdot}2^\circ$ C.

2. CONVERT 145° C. into F.

Since 100° C. are equivalent to 180° F.

$\therefore$ 1° C. is equivalent to $\frac{180^\circ}{100}$ F.

$\therefore$ 145° C. are equivalent to $\frac{145 \times 180^\circ}{100}$ F. = 261° F.

This is 261° above f.p.

$\therefore$ Temperature reading will be 261 + 32 = 293° F.

This calculation can be easily made from the formula $\frac{F - 32}{180} = \frac{C}{100}$, but it is better to reason the matter out as shown.

9. Choice of Liquid for Thermometers.—For ordinary purposes, mercury is the most suitable thermometric liquid.

Mercury is easily seen, and is reasonably sensitive, i.e. it responds to a very small accession of heat, and the heat is rapidly spread through the whole mass. But it freezes at −40° C., and is consequently useless in cold countries. It boils about 350° C., and will therefore register moderately high temperatures. Moreover, within the common limits, equal increments of heat produce equal amounts of expansion and equal rises of temperature at the same time.

For very low temperatures alcohol is used.

Alcohol has also the advantage of being much lighter than mercury, so that the bulb of the thermometer is not so likely to be strained or to break.

On the other hand it boils at 78° C., and even at common temperatures it gives off vapour which is apt to disturb the reading of the thermometer.

Water is in every way inconvenient.

10. Inaccuracies in Thermometers.—Thermometers constructed and graduated as described are accurate enough for most of the purposes of everyday life. In scientific work, however, much greater accuracy is desirable, and a few further points have to be considered. (1) In dividing the space between 0° and 100° into 100 equal divisions with a ruler, we have assumed that the bore or internal calibre of the thermometer tube is uniform throughout. Now this is not often the case exactly; and if it is not, it is evident that equal amounts of expansion of the mercury do not correspond to equal lengths of the tube.

The process of making these two correspond is called the *calibration of the thermometer.*

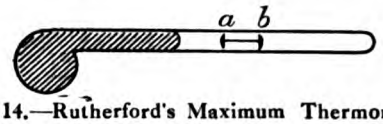


Fig. 14.—Rutherford's Maximum Thermometer.

Fig. 15.—Rutherford's Minimum Thermometer.

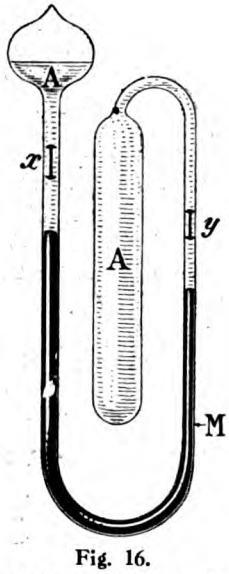


Fig. 16.
Six's Maximum and Minimum Thermometer.

Fig. 17. — Showing the principle of the Clinical Thermometer.

EXPERIMENT.—Take a piece of capillary tubing about a foot long, and suck into it a short thread of mercury, about 4 mm. long. Paste a strip of paper on the tube as shown in Fig. 13. Then mark on the paper the position of the two ends of the mercury *a*, *b*. Tap the tube gently, in order to remove the mercury along until it takes up the position *bc;* mark *c* on the paper, and repeat the process all along the tube. Measure carefully the lengths *ab*, *bc*, *cd*, etc. If they are all equal, the tube is of uniform bore and does not need calibration, since they correspond to equal amounts of mercury. Calibration consists in making the marks *a*, *b*, *c* on the tube itself, so that when we come to graduate the thermometer we can really get equal degrees recorded.

(2) We have hitherto spoken of the mercury as the expanding substance without taking into account the fact that the mercury is enclosed in glass, which also expands. We have mentioned in § 9 that glass may yield slightly to the weight of the mercury in the bulb; but, over and above that, it has been observed that glass which has been heated does not recover itself exactly and at once. Thus, if we mark the freezing-point on a thermometer, and then heat the instrument to 100° and cool it again, it would be found that the freezing-point has apparently fallen as much as 0·2° or even half a degree, according to the nature of the glass. This is because the glass has not quite contracted to its original bulk; and not until some months afterwards can the recovery of the glass be regarded as complete. It follows that accurate thermometers cannot be relied upon if they are used for widely different temperatures at short intervals of time.

11. Maximum and Minimum Thermometers.—Several forms of thermometer have been devised for recording the highest or lowest temperature during a given period.

Rutherford's Maximum Thermometer (Fig. 14) is an ordinary mercury thermometer mounted on a frame so that its stem is horizontal. A small steel index *a b* is pushed forward by the expanding mercury, and is left in its most advanced position when the mercury recedes. Hence the position of *a* indicates the highest temperature reached.

Rutherford's Minimum Thermometer (Fig. 15) is arranged, like the maximum thermometer, with its stem horizontal; but the liquid used is alcohol. As the alcohol contracts, its surface-film drags the index back with it, and leaves it behind on expanding again; *b* indicates the lowest temperature reached.

Six's Thermometer (Fig. 16) is a combined maximum and minimum instrument, and contains both alcohol (A) and mercury (M). The maximum temperature is recorded at *x;* the minimum at *y.*

In *Negretti and Zambra's Maximum Thermometer* (Fig. 17) the tube is bent and constricted immediately above the bulb, so that the mercury which passes beyond the constriction cannot return unless the thermometer is violently shaken. The same applies to medical or *Clinical Thermometers.*

12. High and Low Temperatures.—For measuring very high temperatures, such as the temperature of a furnace, we cannot use instruments made of glass, which melts too easily, nor liquids like mercury. The standard *pyrometer* has air for its expanding substance. The bulb is made of platinum or porcelain.

For low temperatures, the *electrical resistance thermometer* is most useful. E. W. E.

ZOOLOGY.—III

THE greater number of the Primates remain for consideration.

These include a large and diversified group of animals, among which are to be found types as far removed from the higher apes as the latter are from man. Here we have the monkeys and baboons of the Old World, the American monkeys and marmosets, and strange primitive animals—the lemurs and their allies. At first sight there may seem little to associate the lesser members of the order with the towering gorilla; but we find so many structural features characterising the group that, although there is difficulty in effecting the classification, there can be no two opinions as to the common origin of all the members of the great order. They are all mammals with hands.

The Lower Primates.

The mere use of the fore limbs as hands would not by itself suffice to distinguish them. Mice, rats, squirrels, and other rodents employ their fore-paws as hands; the frog, in whom persists the five-fingered "hand" of the early amphibians, uses his to change the position of a worm half swallowed, and employs both hands to clasp the slithery outline of his sweetheart. The lower Primates have, however, a multitude of anatomical features duplicating those of man.

The presence of a tail is not a cancelling disqualification. None of the great apes has one. Some of the present group have none. But the Old World monkeys have the same number of teeth as human beings, and the points of agreement are more remarkable than those of disagreement.

The American monkeys differ from their cousins as to number of teeth; they have the nostrils wide apart, instead of close together as in the Old World types; and some of them have developed a wonderful grasping power in the tail which becomes to them a sort of fifth hand. In the monkeys of the Old World the tail appears to serve as a balancing organ, and the only set-off to this specialisation of the American representatives is the power of many of the former monkeys to effect a great dilation of the cheeks, which serve for the purpose of hastily storing food when the animal is foraging.

Monkeys not of the West which lack this interesting development appear to have descended from ancestors whose food, like that of their existing representatives, consisted chiefly of leaves and young twigs, with the result that they have stomachs modified in a manner remotely suggesting the ruminant for dealing with this kind of diet.

Europe knows but one monkey to-day, the so-called Barbary ape of Gibraltar. In ancient days the order had a wider distribution. The ape of Gibraltar is in reality one of the macaque monkeys, whose ancestors

Photo: W. S. Berridge.

RING-TAILED LEMUR.

The Lemur, which may seem to the casual observer to resemble a fox rather than a man, is probably the connecting link between man and monkey.

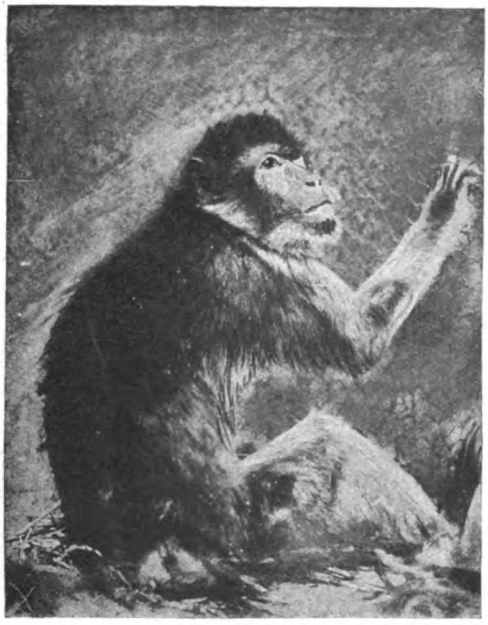
once roamed the primeval forests of Southern England, where lemurs, more primitive than any of their present-day descendants, had, earlier still, been abundantly represented.

The presence of these animals here in days gone by does not, of course, imply a British origin; it tells of old-time land-bridges between the continents, which bridges have now disappeared. Some alteration, too, of climate is connoted; though in this connection it is to be remembered that while the Primates are restricted in the main to the hotter parts of the earth, monkeys are to be found for the seeking among the snow-covered branches of trees flourishing eleven thousand feet up the sides of the Himalayas.

As a fact, the climate of England was hotter in days when lemurs and monkeys were among the early animal Britons.

The lemurs were in all likelihood first here, for they represent the ancestral stock. They stand to-day as survivors of the connecting links between man and monkeys on the one hand, and the lowest quadrupeds on the other.

At a first glance a common lemur would appear to the casual observer to resemble



BARBARY APE.

The only surviving European monkey belongs to the order of macaque monkeys, whose ancestors once roamed the primeval forests of Southern England.

a fox more than a man. The head is fox-like, the muzzle pointed, the nostrils not rounded like those of men and monkeys, but curved slits like those of cat or dog. Yet there in the trees of Madagascar, in the tropical regions of Africa, Southern India, Ceylon and the East Indies, are the descendants of that far-away family from which the Primates radiated into their varying forms and characters. They are for the most part tree-dwellers, relying upon a mixed diet, mainly vegetable, but varied by insects, eggs, and even young birds.

Madagascar is the headquarters of the group to-day.

Lemurs had reached South-eastern Africa, it is supposed, before true monkeys had spread to this area, and the collapse of a land bridge made Madagascar an island, and left such lemurs as had arrived to develop, free from the whirl of the general current of existence which was so radically to remodel then existing life-forms. Not all the lemurs have passed, as we have noted, from scenes beyond Madagascar, but here in this great oceanic island is their capital; and here it is that they have developed their strangest forms.

Here we have the true lemur common to every zoological collection with its startlingly deep voice, and the big bushy tail with which it enwraps its head when sleeping, and its strangely human hands with well-developed nails and thumbs, combined with the grasping feet of the true tree climber.

We have in the Indri, the largest of the lemurs, an almost tailless lemur, in which the soul of a dead man is supposed by the natives to be re-embodied. Indeed, the safety of the lemurs as a whole is due in the main to the superstitious reverence with which they are regarded by the native inhabitants.

This reverence arises from the ghostly character of the lemurs' mainly nocturnal ramblings, coupled with the mournful sounds they utter.

Types of Lemur

Next to the almost tailless Indri come the long-tailed sifakas, which in a mild way reflect among lemurs the leaping powers of the gibbons among anthropoids, although the weasel lemur in this respect runs them close.

We need not follow the lemurs through all their variations of forms, of size and habit; but it is interesting to note that while some have developed on lines approximating to those of the mungoose and the weasel, others preserve for us the dimensions of the earliest undoubted mammals.

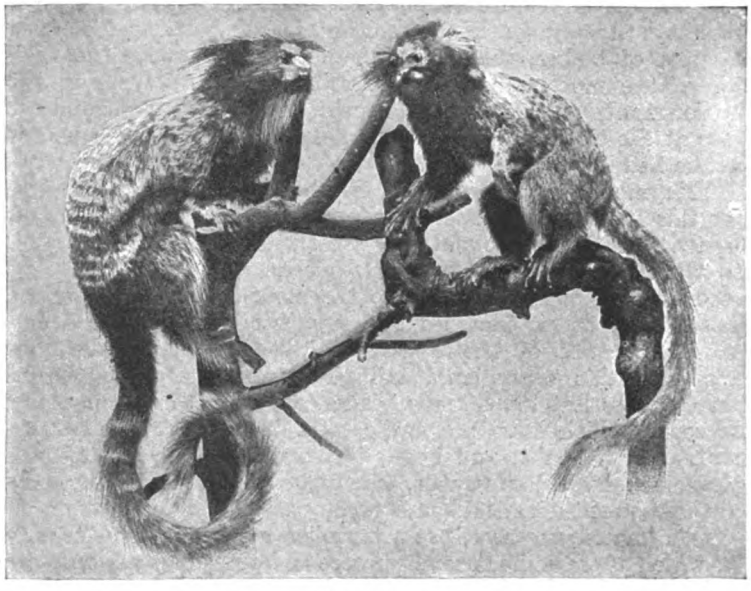
These are the dwarf mouse lemurs, whose little bodies are but four inches in length. Yet they are true Primates, of the same order with man; Primates which fast and sleep away the scorching summer famines as the hedgehog hibernates in barren winter. Another extraordinary lemur-like animal, the aye-aye, has developed the dentition of a rodent, and a skeleton middle finger which suggests the claw of a bird. The purpose of teeth and claw is supposed to be to enable the animal to tear open the trunks of trees and drag out wood-boring larvæ concealed within.

There are other strange related forms in the lorises, one of which, the slow loris, suggests the sloth; the pottos, and the

tarsiers—fantastic little creatures, these latter, with kangaroo-like hind legs, with feet and hands equipped with sucker-pads, and with teeth recalling those of extinct lemurs which connect the lemur group with the monkeys. The tarsier is the most primitive of all the Primates, and for that reason highly to be treasured.

We have dealt so far in this chapter with the very lowest of the Primates, with a group which, regarded as the surviving links with the ancestral forms of the whole order, is now classed as a sub-order of the Primates. We must move now to the higher divisions of the order, taking the marmosets for aid to direction.

Here we have many species of varying sizes, colours and habits. In general they agree in linking the monkey tribe with lower animals. They have the same number of teeth as a man and an Old World monkey; yet in the arrangement of some of its teeth the marmoset shows its affinity to the American monkey, which it further resembles in not being able freely to oppose the thumb to the fingers as man and Old World monkeys can.



MARMOSETS

are American monkeys of a low aberrant type; their relationship to animals of the humbler orders is shown by the size of their litters; monkeys of the higher orders rarely give birth to more than a single young one at a time.

The marmoset is a true American monkey of a low aberrant type, and its relationship to animals of the humbler orders is proved by the fact that whereas monkeys rarely give birth to more than a single young one at a time, marmosets commonly give birth to litters of two or three.

It does not possess the prehensile tail of its American kin, nor the cheek pouches of the Old World type, nor the naked patches on the buttocks distinguishing many of the latter. The food of the marmoset is a mixture of fruits and insects. In Brazil women carry these little creatures in their bosoms, and even concealed in their luxuriant hair.

The American monkeys are placed lower in the scale than their Old World cousins; but inasmuch as they possess in the vicinity of the shoulder-joints muscles which are to be found nowhere else, save in man and the great apes, the question of precedence is by no means finally settled. But the American types have widely separated nostrils; they have four teeth in excess of the number of man and of other monkeys; they have not only tails, but, as to many species, prehensile or grasping tails at that; while many of them have lost their thumbs through ages of disuse, and none can employ them as an Asian or African monkey can.

American monkeys are divided into ten chief groups; of these, the sapajous, the woolly, the spider, the squirrel, the titi, the saki, and the howlers are the chief, though not exclusively the most interesting. In habits they differ little from Old World monkeys in so far as natural surroundings admit. They frequent the great tropical and sub-tropical regions of the river valleys of the southern half of the continent.

Some of the sapajous and sakis, in spite of their widely sundered nostrils, are startlingly like little caricatures of aged men; while, on the other hand, we find among the squirrel monkeys tiny animals whose features are child-like, which smile when pleased, and whose eyes are suffused with tears when the little creatures are sad. These squirrel monkeys resemble squirrels

in size and build, and may be contrasted with the biggest of the howlers, the largest of American monkeys, which have a head-and-body measurement of thirty inches, a tail of about the same length, and a disposition excessively intractable.

In a sense the spider monkeys are the most interesting, as showing in one direction the acme of specialisation.

As in a racehorse we see the finest of lines sought to the end that speed rather than weight-hauling power may result, so by a gradual process Nature has produced in these monkeys fine-drawn lines resulting in the lightest of bodies, the longest, gauntest of limbs, the most remarkable of tails. The spider-monkey's tail is bare on the underside at the tip, and as sure a grasping organ as the hand of a gibbon.

This monkey is practically five-handed, for this specialised tail serves not only as a means whereby the animal may attach itself to the limb of a tree, but as a means of securing and conveying food to the mouth. In this respect it matches the exquisitely sensitive trunk of the elephant. But in acquiring this exceptional tail the spider monkey has lost his thumbs. The howlers, however, which have prehensile tails, have kept their thumbs, and have developed a phenomenal vocal apparatus, seemingly only at the cost of their neighbours' comfort.

The " harrowing roar," as a traveller calls it, which these animals emit proceeds from an interesting modification of the bony structure of the throat, a curious adaptation of what remains the hyoid bone in man. This development has necessitated a widening and deepening of the jaws and a flattening of the skull, and the sole purpose to be served is, so far as we can see, to frighten off enemies.

Old World Monkeys

The Old World monkeys are brigaded into seven genera, and are distributed throughout Africa and the warmer parts of Asia. Nature seems to have wrought unweariedly here, as indeed throughout the lower Primates, to produce infinite variety of garish specialisation. The extraordinary developments attained in some of the genera is not to be explained on the score of utility. The value of a prehensile tail to a monkey is obvious; but why a monkey of the highlands of North-west China should specialise over the most absurd of snub noses, while a monkey peculiar to Borneo, which begins its career with a comical little nose tip-tilted like that of its Chinese relative, blossoms at maturity into possession of so vast a nasal organ as to earn for the animal the name of proboscis monkey, is not so easily explained.

This latter animal has structural affinities with both the langurs of India and the macaques and their allies. It arose from the common ancestral mould, reached Borneo before that island had been parted by the sea from the Asian mainland, and developed there along unique lines, as the lemurs developed in isolated Madagascar, and the pouched mammals in insulated Australasia. Natives are commonly compared by their civilised conquerors to monkeys; in this instance the wild men of Borneo retaliate by applying to the proboscis monkey a name which signifies " white men."

Grotesque and hideous as is this monkey, it is peculiarly interesting to the anatomist as foreshadowing by its unique organ the aquiline nose of the higher human species.

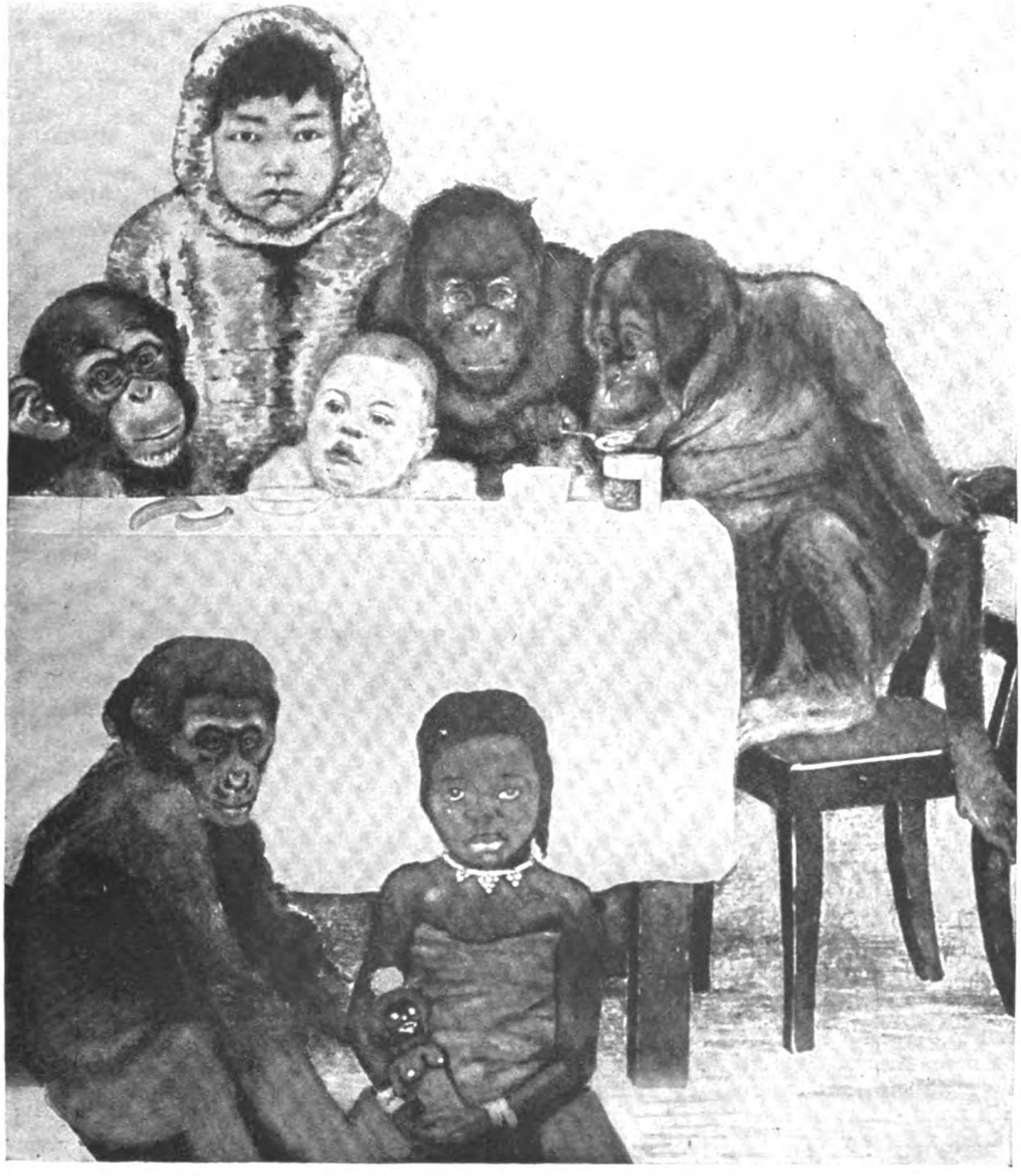
Protective Colours

The langurs of South-eastern Asia, which include the monkeys held in veneration by our Hindu fellow-citizens, are represented in Africa by the guerezas. The latter differ from the former in having lost, or practically lost, their thumbs.

But the progress of divergence can be traced further in the guerezas. We find them arising from a stock almost entirely black in coat, with a slight fringe of white hairs along the flanks, which make the animals invisible among the lichen-clad trees of their forests. From this small beginning in protective coloration have issued great developments in other species—the skull heavily crested, the flanks covered with a white mantle of hair of great length, the tail a vast snowy plume.

Another guereza is white-thighed and white-ruffed, another is habited like a little bear, while a Gold Coast guereza is a mixture of black, grey, bay and red, with a blue face and flesh-coloured nose and lips. All these variations are found in a genus of some eight species, all traceable to-day to a common colour scheme, and all distinctly the kin of the monkeys of another continent to which they present no superficial resemblance.

No matter where they reside—China, India, Africa, or the various tropical islands, the Old World monkeys — langurs, snub-nosed, proboscis, guereza, guenon, mangabeys, macaques—are all one family, though divided into various genera, and into still more species. The baboons, moreover—the last word in simian repulsiveness—are also of that family.



MAN AND HIS COUSINS.

In this remarkable group of young Primates are shown: Behind the table (from left to right) a Chimpanzee; an Asiatic human type (Samoyede); a European human type; and two Orang-utans. In the foreground, a Gorilla and an African human type (Nigerian).

(Reproduced from Dr. P. Chalmers Mitchell's "Childhood of Animals," by courtesy of the publisher, Mr. William Heinemann.)

Except for the unmistakable hands of these animals, the unlearned would find it difficult to trace any kinship between these grim and hideous creatures and the rest of the order to which man belongs. The Greeks, however, learned human anatomy by studying first principles with the body of the macaque (our so-called Barbary ape) as medium ; and we have to-day in the black ape of Celebes the connecting link between macaques and the rest of the monkey tribe.

The Monkey Mind

In all these monkeys and apes, of both the New World and the Old, there is a high degree of intelligence, exceeding in native resource and initiative that of other orders. The baboons combine for defence against the great flesh-eaters, and they associate to raid and rob the plantations of the natives. In captivity, moreover, though they are dangerous, they show affection and teachability excelled only by that of the higher apes.

Some of the monkeys seem almost human in their affection, their tricks and acquirements. The study of their minds has been left for the most part to organ-grinders and foreign animal trainers ; but the few efforts made by scientists to probe the mystery of monkey psychology have yielded fascinating results. The simian brain is far inferior to the brain of the lowest savage ; but for five or six million years man, erect, a thinking being, has been unconsciously cultivating his mental faculties ; the rest of the Primates also have developed their brains, but in infinitely smaller degree.

At the parting of the ways they chose tree-life as the line of least resistance, and four climbing hands were perfected at the cost of mental capacity. Even so, they have outstripped all other orders in mental efficiency, and the full powers of the monkey mind have yet to be discovered. E. A. B.

ASTRONOMY.—III

THE provision of accurate time is one of the necessities of civilisation. When people stayed at home, and their only communication with London was by the slow stage coach, it did not matter very much whether they had any accurate knowledge of the time or not ; if they troubled about the question at all, they generally kept local time—that is to say, on the average the sun was due south at the time they called noon. But as soon as the construction of the system of railways made communication much more rapid, and made the certainty of catching trains a necessity, it became at once more important to have a correct knowledge of the time, and more essential that all parts of the country should have the same time.

The best clock in the world cannot be trusted to maintain a uniform rate over a long period. Unless, therefore, there is some independent check, the time shown by the clock very soon becomes uncertain. In the early days of the British occupation of Egypt it is said that the citadel of Cairo used to fire a gun at noon, as is done in many military centres, and that when, somewhat later, an officer arrived to take charge of the survey, he became curious to know how the citadel obtained its time. Inquiry showed that the gunner obtained it from an excellent clockmaker in the city, and inquiry at the clockmaker's showed that he obtained his time from the gun. The result was that the time of the country had accumulated an error of about fifteen minutes. This kind of thing must happen unless the clocks are controlled by time determined from the stars.

Distributing Time

The first duty of an Observatory is to keep the time and to distribute it. We will inquire how it does so. There is in every observatory a transit instrument—that is, a telescope so mounted that it sweeps up and down the meridian, which is the line from the south point of the horizon straight up through the zenith, through the Pole of the sky, down to the north point of the horizon again.

The field of view of this telescope is provided with a whole series of wires ; but for simplicity we will speak of only one which marks—or should mark—the meridian. When the astronomer wishes to make an observation of time, he selects a star which is in the list of Nautical Almanack clock stars—that is to say, a star whose place in the sky is very accurately known.

A couple of minutes before the star is due he sits down at the instrument, and takes in his hand a kind of telegraph key. An assistant starts the chronograph, which is generally in the form of a revolving drum, covered with paper, on which the clock is marking every second of its beat by giving a flick to the pen which is drawing a continuous spiral line on the drum. The star comes into the field of view, and when it arrives upon the little wire, the observer gives a sudden tap on the telegraph key, which causes the pen of the chronograph to make an additional break in the line

which it is drawing, and which the clock is punctuating with its ticks. The time at which the star crossed the meridian is thus found—the time as shown by the clock. But the Nautical Almanack gives the true time that the star crossed, or the time that the clock ought to have shown if it had been right. The difference between the two is thus the error of the clock.

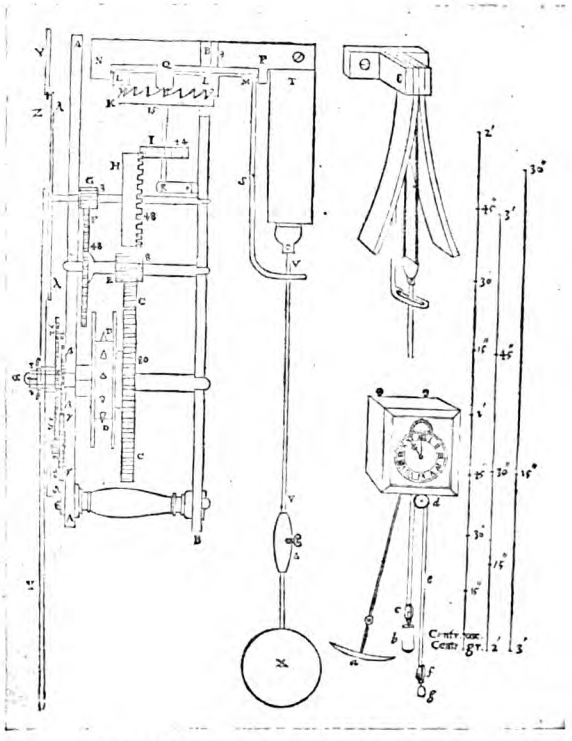
But all this is in star time, or sidereal time, as it is technically called: time which is very convenient to the astronomer, but very inconvenient for ordinary use, since it gains about four minutes a day on the sun, and has 366 days in the year instead of 365. It is not from the desire to make things complicated that the astronomer uses this sidereal time. It is the natural time to use when one is dealing with the stars, because a sidereal day is the interval between two successive passages of a star across the meridian of the observatory.

The Sidereal Clock

In other words, a sidereal day is the time in which the earth makes one complete revolution on its axis; and it differs from the solar day because, while the earth is turning on its axis, it is also moving round the sun, and moves on so much each day that the sun gets about four minutes behind the stars. For ordinary use, however, star time must be translated into sun time, which is done by tables. The astronomer, who translates into the ordinary sun or civil time, thus finds the error of his Mean Time clock.

But having found the error of the clock, he does not attempt to put the clock right until the error accumulated amounts to a minute. For it will be remembered by anyone who has the slightest acquaintance with the mechanism of a clock, that the second-hand is carried on the axis of the escapement wheel, which engages with the pendulum, so that to alter a clock by a few seconds involves stopping the pendulum, or, at any rate, interrupting its regular swing—which is a thing to be avoided in any clock expected to do its best. So the good clocks are allowed to go wrong until, by slow degrees, they have accumulated an error of a minute, fast or slow; and then the minute hand can be put forward or back, without interfering with the action of the escapement wheel and the pendulum.

The astronomer is satisfied if he knows the error of his clock; he does not require that it shall be right. But this will not do for the public distribution of time, so the observatory has another clock of a rougher kind, not so tenderly treated, and sometimes, indeed, called the slave clock. This clock is kept right, generally, by an ingenious contrivance of electro-magnets acting on a bar of iron carried by the pendulum. If, for



HUYGHEN'S PENDULUM CLOCK.

Invented about 1657. The construction is precisely that of the well-known "Cromwell" or Lantern clocks made in England at the end of the seventeenth century.

example, the clock is found a second and a half slow at 10 A.M., and it must be right by noon, electric current is sent through one of the magnets, which temporarily increases the force of gravity upon the clock and makes it go faster, so that it gains a second and a half in the two hours before noon.

This slave clock has mechanism which exactly at the sixtieth second of every sixtieth minute—that is to say, exactly at the hour—will send an electric current through wires leading from the observatory to the General Post Office, and to various time-balls erected at ports and on the coast.

The General Post Office clears all the wires in the country at a minute or two before ten in the morning, to transmit the Green-

wich time signal to every Post Office precisely at ten o'clock. It is a curious circumstance that a country which has taken all this trouble to have a Royal Observatory for the provision of accurate time, and which interrupts the telegraph service every morning in order that the time may be distributed, should at this point have ceased to take any interest in the matter.

The time arrives in the instrument room at the Post Office. But there is rarely any means of giving it to the public, who are not allowed access to the instrument room.

The introduction of wireless telegraphy has made it possible for anyone with a very simple receiving station to pick up the time signals sent out from the Eiffel Tower in Paris. This wireless time service offers clockmakers such a ready and inexpensive way of obtaining accurate time, that it will be worth while to go into a few details.

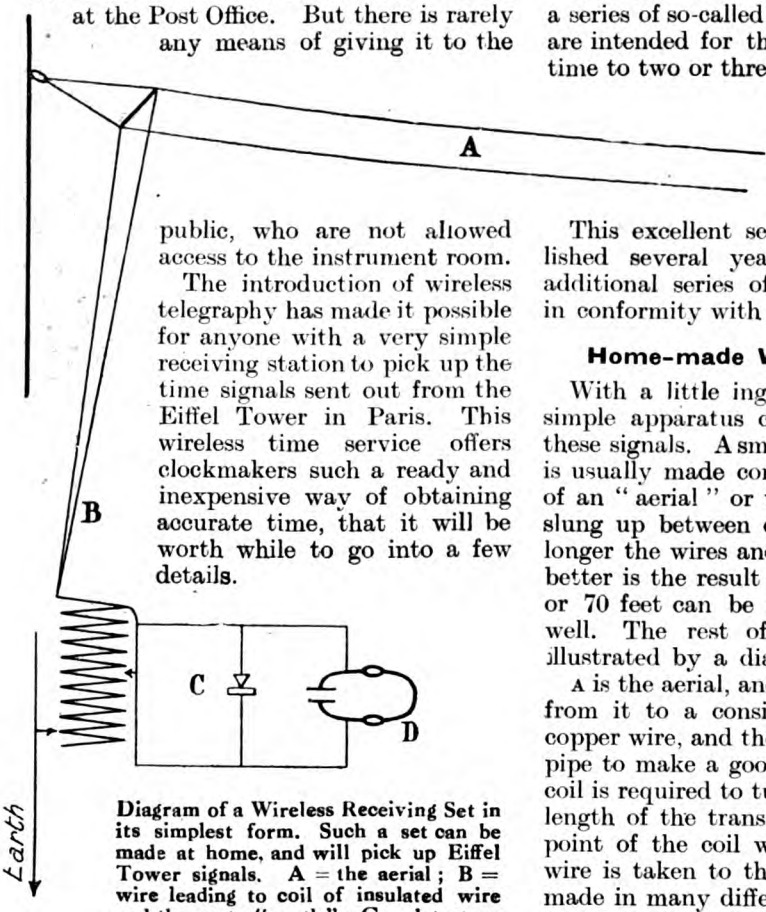


Diagram of a Wireless Receiving Set in its simplest form. Such a set can be made at home, and will pick up Eiffel Tower signals. A = the aerial; B = wire leading to coil of insulated wire and thence to "earth"; C = detector; D = telephone laid across the "poles" of the detector.

But first we will describe what is heard by the man who sits with the telephone strapped to his head at a wireless station. At 10.42 A.M. the Eiffel Tower sends out the general call, and the words, "Paris Observatoire Signaux Horaires." At 10.44 the telegraph operator who stands in the underground clock-room at the Paris Observatory, in electrical connection with the Eiffel Tower, begins to send every five seconds a single long signal which goes until 10.44·55, when he switches the clock into the circuit, and the clock itself sends the short signal exactly at 10.45. At 10.46 the operator begins again with a long signal followed by two shorts every five seconds, and then again at 10.47 the clock sends its signal. Another signal, preceded by a series of long followed by four shorts, comes at 10.49, after which the Observatory is cut out, and the Meteorological Office begins to talk about the weather all over Europe and out into the Atlantic.

At 11.30 P.M. the Observatory sends out a series of so-called rhythmical signals, which are intended for the accurate comparison of time to two or three hundredths of a second, and which scarcely concern the ordinary observer. At 11.45 a series of signals like those in the morning is sent out again.

This excellent service of time was established several years ago. More recently, additional series of signals have been sent in conformity with an international scheme.

Home-made Wireless Apparatus

With a little ingenuity an extraordinarily simple apparatus can be made to receive these signals. A small private wireless station is usually made conspicuous by the erection of an "aerial" or two or more copper-wires slung up between chimneys or masts. The longer the wires and the higher they are, the better is the result; but a length of 60 feet or 70 feet can be made to serve perfectly well. The rest of the apparatus is best illustrated by a diagram.

A is the aerial, and B is a wire leading down from it to a considerable coil of insulated copper wire, and thence to the nearest water-pipe to make a good earth connection. The coil is required to tune the aerial to the wave length of the transmitting station. From a point of the coil which is found by trial a wire is taken to the detector, which can be made in many different forms, but generally consists of two crystals, as of zincite and bornite, which have the curious property when they are in delicate contact of allowing the electric current to pass in one direction but not to return. C is the detector. D is a telephone across the poles of the detector.

The electric waves which fall on the aerial set up oscillations in it backwards and forwards. The current will pass one way through the detector, but not the other; and the result is a buzzing in the telephone receiver which for the Eiffel Tower signals resembles the roll of a distant kettle-drum. Our description of the apparatus is reduced to its simplest terms, and there are many accessories which must be introduced if one

wants to get good results. But the signals from the Eiffel Tower are so strong that only very elementary apparatus is required to receive them.

We should now go back to the Observatory, to learn a little more of the transit instrument, which illustrates very well many of the fundamental principles of precise observational work.

The transit instrument consists of a telescope whose optical axis is supposed to be at right angles to the axis on which the instrument turns up and down in the meridian. This horizontal axis rests in **V**-bearings upon two piers, and is supposed to be exactly horizontal and exactly east and west. The piers are built on very massive foundations, and they are supposed to remain exactly in position from day to day. The highest skill of the instrument maker has been devoted to making an instrument which shall satisfy all these conditions; yet the first impression the student of practical astronomy derives from a course of instruction is that the transit instrument is nothing but a bundle of errors; and this is true.

No instrument can possibly be made so well that it cannot be convicted of error. The skill of the maker is devoted as much to contriving arrangements which shall convict his instrument of continually varying errors, as it is to rendering that instrument, in the first place, as free from error as possible. The whole routine of transit observing is, therefore, a continual battle against instrumental shortcomings.

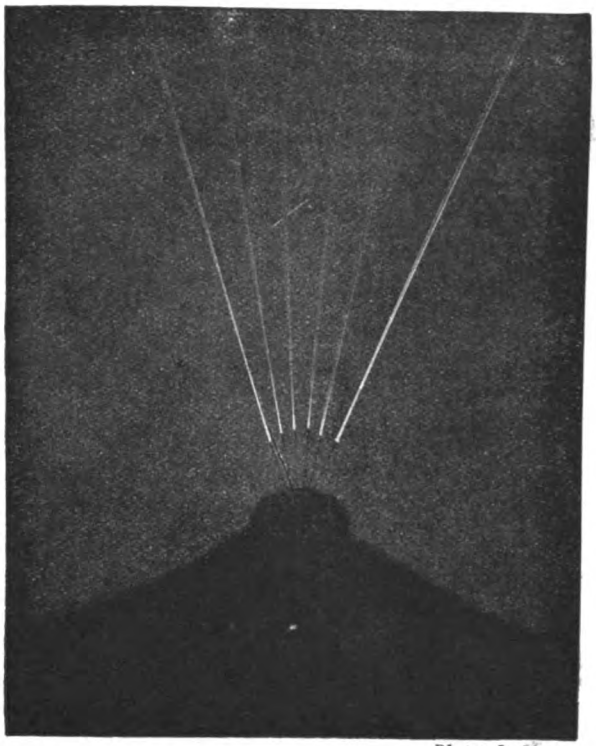
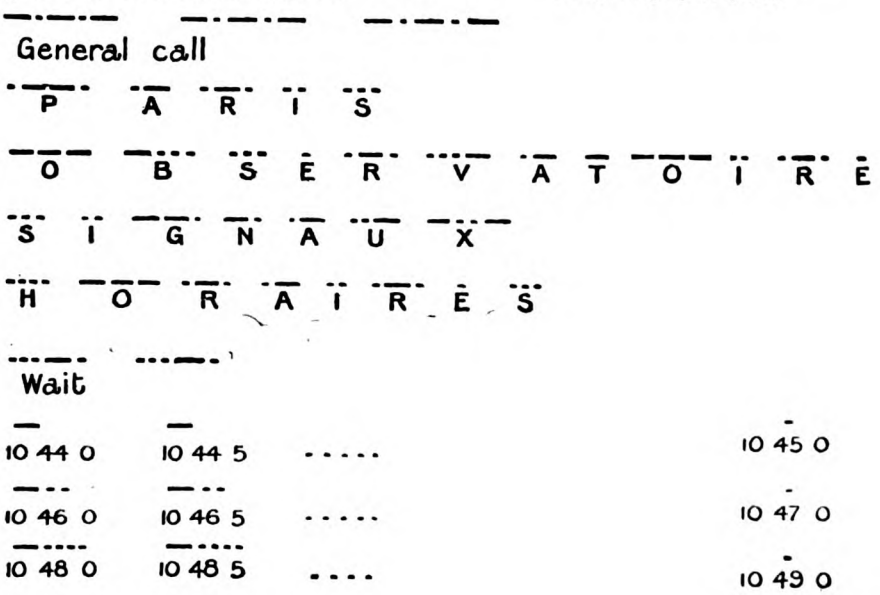


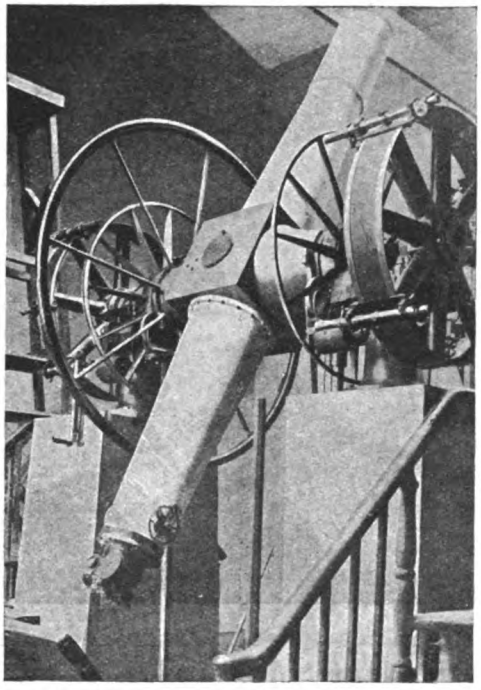
Photo: L. Gimpel.

THE EIFFEL TOWER ANNOUNCING GREENWICH TIME.

This photo was taken from the second platform of the tower. The ultra-violet radiations appear luminous on the photographic plate.



The piers may be firmly embedded in the ground; but the ground itself will move with the change of temperature between summer and winter, or the varying amount of water in the sub-soil. The instrument is also affected by temperature, for it cannot be made so symmetrical that temperature makes it grow or shrink in exactly the same



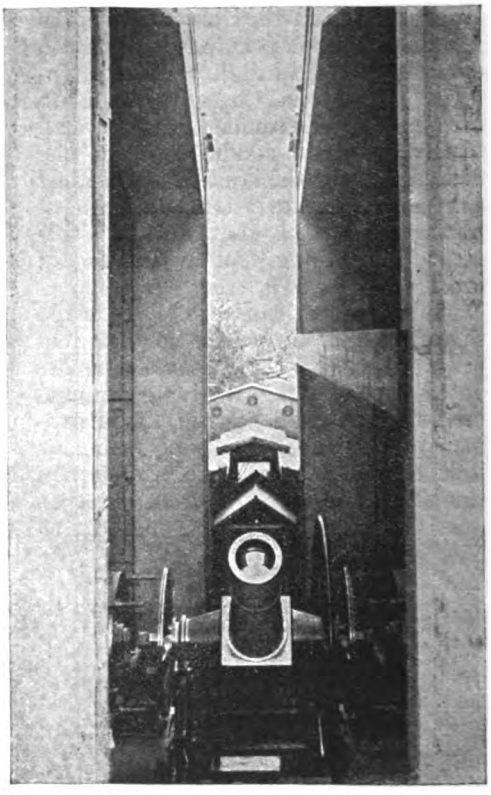
FOR DETERMINING SIDEREAL TIME.
The transit instrument at the Cambridge Observatory.

proportions all over. Consequently, the life of the transit observer is one long battle with instrumental errors. And this is typical of all refined instrumental work. One first builds an instrument with every refinement or precaution; and then one treats it with remorseless suspicion, and makes continual and invariably successful attempts to convict it of error.

We have already learned that the time is first determined from the stars, and then brought into relation with the sun, whose rising and setting controls the ordinary day. One may very well ask: "Why not observe the sun directly?" There are many reasons why this would not do. One very practical reason is that the sun crosses the meridian only once a day; and that if one had to rely upon it being clear at that moment, one would find a great many days passing without an observation of time; whereas if one works with the stars, one has a much better chance of snatching a few moments clear weather at some time of day or night.

A second reason is that the sun is very large and a very hot body to observe. Its size is a disadvantage because, its centre not being well marked, one is compelled to observe first one side and then the other, and take the mean of the two, which would be all very well were it not for the fact that such observations are by no means so accurate as observations on a star.

Moreover, it is, of course, well known that the motion of the sun is not regular, but suffers from an inequality called the "equation of time," due partly to the fact that the earth's path round the sun is not a circle but an ellipse, and partly to the fact that



THE CAMBRIDGE OBSERVATORY MERIDIAN CIRCLE.
As seen through the shutter opening.

the sun in its path among the stars is sometimes north of the Equator and sometimes south of it. The result of this combination of irregularities is that the length of the solar day, or the time between consecutive passages of the sun across the meridian, is variable. The solar day in September is twenty seconds longer than in December.

A. R. H.

Continued from page 102

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—III

The Third Declension

The third declension is more complicated than the first and second, and requires a greater effort of memory. The nominative singular presents a variety of terminations, from which it is not always easy to ascertain the base, so that it is necessary in each case to learn the genitive singular as well as the nominative.

There are two distinct classes of nouns in this declension :—

(1) Those which have for characteristic letter a consonant, the plural genitive ending **-um** being always preceded by a consonant.

(2) Those which have for characteristic letter the half-consonant **i**, the genitive plural ending in **-ium**.

The words in the first of these divisions are imparisyllabic, the number of syllables in the gen. sing. being unequal to (more than) that of the nom. sing. Thus the gen. sing. of **jūdex** is **jūdĭcĭs**, and of **lĕo**, **leōnis**. The words in the second division are parisyllabic, the number of syllables in the nom. sing. being the same as in the gen. sing. Thus the gen. sing. of **nūbes** is **nūbis** and of **mărĕ**, **măris**. To this general rule, however, there are exceptions, especially in the I-division, which contains many imparisyllabic nouns.

I. Consonant-Nouns

Masculine and Feminine

Jūdex (c.), *judge ; base*, **jūdic-**.

	Sing.	*Plur.*
Nom.	jūde-**x.**	judĭc-**ēs.**
Voc.	jūde-**x.**	judĭc-**ēs.**
Acc.	judĭc-**em.**	judĭc-**ēs.**
Gen.	judĭc-**ĭs.**	judĭc-**um.**
Dat.	judĭc-**ī.**	judĭc-**ĭbŭs.**
Abl.	judĭc-**ĕ.**	judĭc-**ĭbŭs.**

Hŏmo (m.), *a man ; base*, **hŏmin-**.

	Sing.	*Plur.*
Nom.	homo.	homĭn-**ēs.**
Voc.	homo.	homĭn-**ēs.**
Acc.	homĭn-**em.**	homĭn-**ēs.**
Gen.	homĭn-**ĭs.**	homĭn-**um.**
Dat.	homĭn-**ī.**	homĭn-**ĭbŭs.**
Abl.	homĭn-**ĕ.**	homĭn-**ĭbŭs.**

Neuter.

Căpŭt, *head ; base*, **căpĭt-**.

	Sing.	*Plur.*
Nom.	caput.	capĭt-**ă.**
Voc.	caput.	capĭt-**ă.**
Acc.	caput.	capĭt-**ă.**
Gen.	capĭt-**ĭs.**	capĭt-**um.**
Dat.	capĭt-**ī.**	capĭt-**ĭbŭs.**
Abl.	capĭt-**ĕ.**	capĭt-**ĭbŭs.**

Tempŭs, *time ; base*, **tempor-**.

	Sing.	*Plur.*
Nom.	tempŭ-**s.**	tempŏr-**ă.**
Voc.	tempŭ-**s.**	tempŏr-**ă.**
Acc.	tempŭ-**s.**	tempŏr-**ă.**
Gen.	tempŏr-**ĭs.**	tempŏr-**um.**
Dat.	tempŏr-**ī.**	tempŏr-**ĭbŭs.**
Abl.	tempŏr-**ĕ.**	tempŏr-**ĭbŭs.**

You will carefully notice that the increase in the number of syllables is commonly accompanied by a change in the vowel, from **e** to **i** in **jūdex**, from **o** to **i** in **homo**, and from **u** to **o** in **tempus**. The **e** of **jūdic-** changes to **x** in the nom. sing., and in the same way **dūc-**, *leader*, gives nom. sing. **dux**, and **lēg-**, *law*, gives nom. sing. **lex**. In **aestās** the **t** of the base **aestāt-** is dropped before the **s** of the nom. sing., the same thing happening to the **d** in **lăpĭd-**, *stone*, which becomes **lăpĭs**. Note also that the **n** in **hŏmin-** is dropped in the nom. sing. **hŏmo**, and the **r** in **tempŏr-** becomes **s** in **tempus**.

In dictionaries and vocabularies the gen. sing. is given as well as the nom. sing., and the student should carefully commit both forms to memory when each word is learnt.

II. I-Nouns

Masculine and Feminine

1. Nūbē-**s** (f.), *cloud ; base*, **nub-**.

	Sing.	*Plur.*
Nom.	nub-**ēs**.	nub-**ēs**.
Voc.	nub-**ēs**.	nub-**ēs**.
Acc.	nub-**em**.	nub-**ēs** (-**is**).
Gen.	nub-**is**.	nub-**ium**.
Dat.	nub-**ī**.	nub-**ĭbŭs**.
Abl.	nub-**ĕ**	nub **ĭbŭs**.

2. Nāvĭ-**s** (f.), *ship ; base*, **nav-**.

	Sing.	*Plur.*
Nom.	nav-**is**.	nav-**ēs**.
Voc.	nav-**is**.	nav-**ēs**.
Acc.	nav-**em** (-**im**).	nav-**ēs** (-**is**).
Gen.	nav-**is**.	nav-**ium**.
Dat.	nav-**ī**.	nav-**ĭbŭs**.
Abl.	nav-**ĕ** (-**i**).	nav-**ĭbŭs**.

3. Urbs (f.), *city ; base*, **urb-**.

	Sing.	*Plur.*
Nom.	urb-**s**.	urb-**ēs**.
Voc.	urb-**s**.	urb-**ēs**.
Acc.	urb-**em**.	urb-**ēs** (-**is**).
Gen.	urb-**is**.	urb-**ium**.
Dat.	urb-**ī**.	urb-**ĭbŭs**.
Abl.	urb-**ĕ**.	urb-**ĭbŭs**.

4. Dens (m.), *tooth ; base*, **dent-**.

	Sing.	*Plur.*
Nom.	den-**s**.	dent-**ēs**.
Voc.	den-**s**.	dent-**ēs**.
Acc.	dent-**em**.	dent-**ēs** (-**is**).
Gen.	dent-**is**.	dent-**ium**.
Dat.	dent-**ī**.	dent-**ĭbŭs**.
Abl.	dent-**ĕ**.	dent-**ĭbŭs**.

Neuter

5. Rētĕ, *net ; base*, **ret-**.

	Sing.	*Plur.*
Nom.	ret-**ĕ**.	ret-**ĭă**.
Voc.	ret-**ĕ**.	ret-**ĭă**.
Acc.	ret-**ĕ**.	ret-**ĭă**.
Gen.	ret-**is**.	ret-**ium**.
Dat.	ret-**ī**.	ret-**ĭbŭs**.
Abl.	ret-**ī**.	ret-**ĭbŭs**.

In some nouns of the I-division we find an alternative ending **-i** in the ablative singular, and in other instances an alternative ending **-im** in the accusative singular. The older ending of the accusative plural of masculine and feminine nouns in this division is **-is**, but the form usually printed, especially in prose works, is **-es**. The alternative endings are shown above in brackets.

Masculine and feminine nouns of this division normally add **-es** or **-is** to the base in the nom. sing., and are parisyllabic. Words of which the base ends in two consonants take the suffix **-s** in the nom. sing., as in **urbs**, dropping a dental before the **-s** in words like **dens**, base **dent-**.

Adjectives of the Third Declension

There are two classes of adjectives in Latin, of which we have already dealt with one, consisting of those declined in the masculine and neuter genders like nouns of the second declension, and in the feminine like nouns of the first declension. All other adjectives fall into a second class consisting of those that follow the third declension in all genders.

Adjectives of this class, like nouns of the same declension, fall into two main divisions according as the genitive plural ends in **-um** or **-ium** :—

(1) Adjectives having the gen. plur. ending in **-um** are declined like consonant-nouns of this declension.

(2) Adjectives with the gen. plur. ending in **-ium** are declined like I-nouns.

Adjectives Declined like Consonant-Nouns

(A) The majority of adjectives in this division have the base in **-or**, expressing the comparative degree, the neuter ending in **-us**.

Mēlĭŏr, *better ; base*, **mēlĭŏr-**.

	Sing.		*Plur.*	
	Masc. and Fem.	*Neut.*	*Masc. and Fem.*	*Neut.*
N.V.	meliŏr	meliŭs.	meliōr-**ēs**	meliōr-**ă**.
Acc.	meliōr-**em**	meliŭs.	meliōr-**ēs**	meliōr-**ă**.
Gen.	meliōr-**is**	meliōr-**is**.	meliōr-**um**	meliōr-**um**.
Dat.	meliōr-**ī**	meliōr-**ī**.	meliōr-**ĭbŭs**	meliōr-**ĭbŭs**.
Abl.	meliōr-**ĕ**	meliōr-**ĕ**.	meliōr-**ĭbŭs**	meliōr-**ĭbŭs**.

(B) Some few adjectives in the consonant-division have only one form in the nom. sing. for all genders, and are declined as though they were simply nouns of the third declension. It should be noted that in this group the base ends in a short syllable.

Dīvĕs, *rich ; base*, **dīvĭt-**.

	Sing.	*Plur.*
N.V.	dīvĕ-**s**.	dīvĭt-**ēs**.
Acc.	dīvĭt-**em**.	dīvĭt-**ēs**.
Gen.	dīvĭt-**is**.	dīvĭt-**um**.
Dat.	dīvĭt-**ī**.	dīvĭt-**ĭbŭs**.
Abl.	dīvĭt-**ĕ**.	dīvĭt-**ĭbŭs**.

Decline the following :—After the model of **melior**, fortior, *braver*, and brevior, *shorter ;* after the model of **dives**, sospēs, (base sospĭt), *safe*, caelebs (caelĭb-), *unmarried*, and paupĕr, *poor*.

Adjectives Declined like I-Nouns

These are comprised in three groups.

(A) The adjectives of three terminations in the nom. sing. form the smallest group.

Ācĕr, ācrĭs, ācrĕ, *sharp; stem,* **acr-**.

	Sing.			*Plur.*	
	Masc.	*Fem.*	*Neut.*	*Masc. and Fem.*	*Neut.*
N.V.	ac-**ĕr**	acr-**ĭs**	acr-**ĕ.**	acr-**ēs**	acr-**ĭa.**
Acc.	acr-**em**	acr-**em**	acr-**ĕ.**	acr-**ēs**	acr-**ĭa.**
Gen.	acr-**ĭs**	acr-**ĭs**	acr-**ĭs.**	acr-**ĭum**	acr-**ĭum.**
Dat.	acr-**ī**	acr-**ī**	acr-**ī.**	acr-**ĭbŭs**	acr-**ĭbŭs.**
Abl.	acr-**ī**	acr-**ī**	acr-**ī.**	acr-**ĭbŭs**	acr-**ĭbŭs.**

The stem was originally **ācĕr-**, but the **e** before the **r** is dropped except in the nom. sing. The only adjective in this group not dropping the **e** is **cĕlĕr**, which retains it in both the nominative **cĕlĕr**, **cĕlĕrĭs**, **cĕlĕrĕ**, and the oblique cases.

(B) Adjectives of two terminations in nom. sing., one ending in **-is** for the masculine and feminine, and the other ending in **-e** for the neuter, are declined thus :—

Făcīlĭs, *easy; base,* **făcĭl-**.

	Sing.		*Plur.*	
	Masc. and Fem.	*Neut.*	*Masc. and Fem.*	*Neut.*
N.V.	facil-**ĭs**	facil-**ĕ.**	facil-**ēs**	facil-**ĭă.**
Acc.	facil-**em**	facil-**ĕ.**	facil-**ēs**	facil-**ĭă.**
Gen.	facil-**ĭs**	facil-**ĭs.**	facil-**ĭum**	facil-**ĭum.**
Dat.	facil-**ī**	facil-**ī.**	facil-**ĭbŭs**	facil-**ĭbŭs.**
Abl.	facil-**ī.**	facil-**ī.**	facil-**ĭbŭs**	facil-**ĭbŭs.**

(C) The other adjectives of this declension have only one form of the nom. sing. for all genders. Note that the base ends in a long syllable, and compare with the similar group in the consonant division differing from these by having in the gen. plur. the ending in **-um**.

Fēlix, *happy; base,* **fēlīc-**.

	Sing.		*Plur.*	
	Masc. and Fem.	*Neut.*	*Masc. and Fem.*	*Neut.*
N.V.	feli-**x**	feli-**x.**	felīc-**ēs**	felīc-**ĭă.**
Acc.	felīc-**em**	feli-**x.**	felīc-**ēs**	felīc-**ĭă.**
Gen.	felīc-**ĭs**	felīc-**ĭs.**	felīc-**ĭum**	felīc-**ĭum.**
Dat.	felīc-**ī**	felīc-**ī.**	felīc-**ĭbŭs**	felīc-**ĭbŭs.**
Abl.	felīc-**ī**	felīc-**ī.**	felīc-**ĭbŭs**	felīc-**ĭbŭs.**

Ămans, *loving; base,* **ămant**.

	Sing.	*Plur.*	*Sing.*	*Plur.*
	Masc. and Fem.		*Neut.*	
Nom.	aman-**s**	-t-**ēs.**	aman-**s**	-t-**ĭă.**
Voc.	aman-**s**	-t-**ēs.**	aman-**s**	-t-**ĭă.**
Acc.	amant-**em**	-t-**ēs** (-**is**).	aman-**s**	-t-**ĭă.**
Gen.	amant-**ĭs**	-t-**ĭum.**	amant-**ĭs**	-t-**ĭum.**
Dat.	amantī	-t-**ĭbŭs.**	amant-**ī**	-t-**ĭbŭs.**
Abl.	amant-**ī** (-ĕ)	-t-**ĭbŭs.**	amant-**ī** (-ĕ)	-t-**ĭbŭs.**

Decline the following :—Like **acer**, ălăcer, *brisk*, vŏlŭcer, *winged*, and silvester, *woody*; like **facilis**, tristis, *sad*, and brevis, *short*; after the model of **felix**, audax, *bold*, and fĕrox, *haughty*, and after **amans**, ingens, *vast*, and sapiens, *wise*. It will be good practice to decline any of these adjectives in pairs with nouns from the following vocabulary. They of course agree in gender and number with the nouns.

VOCABULARY

altus, -a, -um, *high.*
ănīmăl, -ālis (n.), *animal.*
ănīmus, ī (m.), *mind, soul.*
arbŏr (older form, arbos), -ŏris (f.), *tree.*
ars, artis (f.), *art.*
cănis, -is (gen. pl. -um), (c.), *dog.*
cantat, *he sings.*
cantant, *they sing.*
corpus, -pŏrus (n.), *body.*
fertĭlis, -e, *fertile.*
fĭdēlis, -e, *faithful.*
flōs, -ōris (m.), *flower.*
fortis, -e, *brave.*
fortior, -ius, *braver.*
gŭbernātor, -tōris (m.), *pilot.*
illī, *to him.*
illīs, *to them.*
immortālis, -e, *immortal.*
laus, -dis (f.), *praise.*
lĕo, -ōnis (m.), *lion.*
lĭtĕrae, -ārum (f., pl.), *letters, knowledge, literature.*
māter, -tris (gen. pl. -trum), (f.), *mother.*
mons, montis (m.), *mountain.*
mors, -tis (m.) (f.), *death.*
mortālis, -e, *mortal.*
nāvis, -is (f.), *ship.*
nātus, -ī (m.), *child.*
nōbis, *to us.*
pars, -tis (f.), *part.*
passĕr, is (m.), *sparrow.*
pātrĭa, -ae (f.), *one's country.*
plĕtas, ātis (f.), *piety.*
prōvĭdus, -a, -um, *prudent.*
puppis, -is (f.), *stern.*
rāmus, -ī (m.), *branch.*
rex, rēgis (m.), *king.*
săpiens, -ntis, *wise.*
stat, *he stands.*
stant, *they stand.*
sŭus, -a, -um, *his, his own.*
vīta, -ae (f.), *life.*
vox, vōcis (f.), *voice.*

Exercise 3

Translate into English :—

1. Magnus est illi amor patriae suae. 2. Multae columbae in silvis et in montibus aquilae sunt. 3. Leo est rex animalium. 4. Sunt multi flores in insula et multae arbores in monte. 5. Passeres saepe in ramis arborum cantant. 6. Ars longa, vita brevis est. 7. Gubernator navis in puppe stat. 8. Animal providum et sapiens homo est. 9. Vox populi est vox dei. 10. Nati fortium virorum fortes et boni sunt.

Translate into Latin :—

1. There are not many cities in the island. 2. The love of his people is pleasing to a wise king. 3. In the high mountains of Italy is a great abundance of trees. 4. The bodies of men are mortal, their souls immortal. 5. I have many foreign slaves. 6. All Gaul is divided into three parts. 7. The brave father and mother have braver children. 8. Diligent boys love knowledge. 9. Your father's garden is fertile. 10. Your sister has a sweet voice.

Key to Exercise 1

1. An eagle's wing. 2. Abundance of roses. 3. The poet is a husbandman. 4. The daughters of the scribes. 5. The plants are roses. 6. The dove is the prey of the eagles. 7. The moon is a joy to the woods. 8. The daughter of the poet is queen of the earth. 9. There are frogs in the island. 10. The shape of the moon.

1. Mensae. 2. Copia aquae. 3. Laetitia nautarum. 4. Rosa est regina plantarum. 5. Puella est filia poetae. 6. Figura lunae. 7. Mensa scribarum. 8. Reginae insulae. 9. Rosa est planta insulae. 10. Laetitia filiarum poetae. E. A. B.

FRENCH.—III

The Verbs Avoir and Être (*continued*)

The Negative.—To give the negative of a verb, the negative particle **ne** is placed before it, and usually the word **pas** (literally, *a step*) after it, as in—

Je n'ai pas le cheval, *I have not the horse.*
Vous n'avez pas la maison, *You have not the house.*

The word **pas** intensifies the meaning, this form of words once being an emphatic negative, though the emphasis is now lost.

In compound tenses the **ne** is placed before the auxiliary and the **pas** between this and the participle, as in—

Je n'ai pas eu le cheval, *I have not had the horse.*
Vous n'avez pas eu la maison, *You have not had the house.*

Other intensifying words may take the place of **pas,** as follows :—

(1) point, *a point, a jot,* as in Je ne l'ai point vu, *I have not seen him.*
(2) jamais, *never,* as in Vous n'avez jamais le couteau, *You never have the knife.*
(3) rien, *nothing, anything,* as in Nous n'avons rien, *We have nothing.*
(4) personne, *anybody, nobody,* as in Personne n'a le livre, *Nobody has the book.*
(5) plus, *any more,* as in Je ne l'ai plus vu, *I did not see him any more.*
(6) guère, *much, scarcely,* as in Je n'ai guère l'argent nécessaire, *I scarcely have the necessary money.*
(7) que, *but, only,* as in Je n'ai que cela à faire, *I only have this to do.*
(8) ni...ni, *neither...nor,* as in Je n'ai ni le livre ni le papier, *I have neither the book nor the paper.*

These words, used with the negative particle, have a positive meaning of their own, but by constant association with the negative they have tended to lose this, and are regularly used without the particle **ne** when the negative is used without a verb, as in replies to questions.

Examples :—

Avez-vous vu quelqu'un ? Personne. *Have you seen any one ? Nobody.*
Avez-vous quelque chose ? Rien. *Have you anything ? Nothing.*
Avez-vous rencontré cet homme ? Jamais. *Have you met this man ? Never.*

With the infinitive both the negative particle and the strengthening word are usually placed together before the verb, as in—

Il craint de ne pas comprendre, *He is afraid not to understand* (he is afraid of misunderstanding).

When **de** is used with a **substantive** in the partitive sense in a negative sentence, the article is omitted before the substantive, as in—

Nous n'avons pas d'argent (*not* de l'argent), *We have no money.*
Vous n'avez pas de viande, *You have no meat.*

Avoir in the Negative and the Interrogative

Present Indicative

Je n'ai pas, *I have not.*	n'ai-je pas ? *have I not ?*
tu n'as pas, *thou hast not.*	n'as-tu pas ? *hast thou not ?*
il n'a pas, *he has not.*	n'a-t-il pas ? *has he not ?*
elle n'a pas, *she has not.*	n'a-t-elle pas ? *has she not ?*
nous n'avons pas, *we have not.*	n'avons-nous pas ? *have we not ?*
vous n'avez pas, *you have not.*	n'avez-vous pas ? *have you not ?*
ils n'ont pas, *they have not.*	n'ont-ils pas ? *have they* (m.) *not ?*
elles n'ont pas, *they have not.*	n'ont-elles pas ? *have they* (f.) *not ?*

When the subject of an interrogative sentence is not a personal pronoun, it is placed before the verb, and a pronoun agreeing with it in gender, number, and person is placed immediately after the verb ; thus—

Le médecin a-t-il de l'argent ? *Has the physician money ?*
Le boucher a-t-il de la viande ? *Has the butcher meat ?*
Mes frères sont arrivés : les vôtres sont-ils partis ? *My brothers have arrived : are yours gone ?*
Cela est-il vrai ? *Is that true ?*
La sœur du médecin a-t-elle du papier et de l'encre ? *Has the physician's sister paper and ink ?*

You will notice from the last example that the article is repeated before every noun used in a partitive sense, as again in—

vous avez du pain, du beurre, et du fromage, *you have bread, butter, and cheese.*

Idiomatic Uses of Avoir

One of the difficulties of French to beginners—but also, when the language becomes better known, one of its charms—is the abundance of idiomatic expressions.

An idiom is a form of expression, differing more or less from grammatical or logical correctness, that is peculiar to a language or dialect. Thus in English we say, "I feel sleepy," or "Is anything the matter with you ?" These are idiomatic phrases, and to a foreigner learning the language would require some explanation. A French-

man would say, j'ai sommeil, *I have sleep*, or avez-vous quelque chose? *Have you anything?* meaning the same thing as the two English phrases just given. Similarly the French idiom requires explanation.

Very careful attention must be given to these differences between the two languages, and in addition to memorising the vocabularies the student should commit to memory every fresh idiom he comes across.

The verb **avoir** is used with other words, such as faim, *hunger*, froid, *cold*, peur, *fear*, soif, *thirst*, to express ideas which in English we should express by means of an adjective and some part of the verb *to be*.

Examples:—

elle a chaud, *she is warm.*
ils ont faim, *they are hungry.*
nous avons honte, *we are ashamed.*
avez-vous peur? *are you afraid?*
il a tort, *he is wrong.*
vous avez raison, *you are right.*
avez-vous sommeil? *are you sleepy?*
avez-vous quelque chose? *is anything the matter with you?*
je n'ai rien (lit., *I have nothing*), *nothing is the matter with me.*

The name of the person or thing possessing comes after that of the object possessed, the connection being expressed by the preposition **de,** *of*.

Examples:—

la maison du capitaine, *the captain's house.*
le livre de la dame, *the lady's book.*
la lettre de la sœur du boulanger, *the baker's sister's letter.*
l'arbre du jardin, *the tree of the garden.*

The material of which anything consists is expressed by a noun following the preposition **de.**

Examples:—

un habit de drap, *a cloth coat.*
une robe de laine, *a woollen dress.*
la montre d'or, *the gold watch.*
un jet d'étincelles, *a burst of sparks.*

We have an extension of the same idiom in—

une maison de campagne, *a country house.*

VOCABULARY

soldats d'infanterie légère, *light infantry soldiers.*
l'ami (m.), *the friend.*
beau, *handsome.*
bon, *good.*
le bouton, *the button.*
le café, *the coffee.*
cela, *that.*
le chapeau, *the hat.*
le curé, *the curé.*
du tout, *at all.*
l'enfant (m. or f.), *the child.*
entendu, *heard, understood.*
le gibier, *game.*
ici, *here.*
le lait, *the milk.*
le livre, *the book.*
la livre, *the pound.*
mais, *but.*
le marchand, *the merchant.*
non, *no.*
le pain, *the bread.*
la patrie, *one's country.*
pour, *for.*
rencontré, *met.*
le sel, *the salt.*
la soie, *the silk.*
le tailleur, *the tailor.*
le toit, *the roof.*
le vin, *the wine.*

Exercise 3

1. Vous n'avez pas une robe de soie. 2. N'a-t-il jamais eu une montre d'or? 3. Ne l'avez-vous pas vu? 4. Je ne l'ai point vu. 5. A-t-il quelque chose? Il n'a rien. 6. Avez-vous rencontré quelqu'un? Personne. 7. Je ne serai plus ici. 8. Vous n'aurez guère le temps pour cela. 9. Nous n'aurions ni toit ni patrie. 10. Nous n'avons pas de gibier. 11. N'a-t-elle pas de chapeau? 12. Le marchand n'a-t-il pas d'argent? 13. Avez-vous sommeil? Point du tout. 14. Vous avez tort. 15. N'avez-vous pas froid? Non. 16. Ils ont raison. 17. Le tailleur a l'habit de drap du curé. 18. Le père a de la viande, vous avez du café, et j'ai de l'eau. 19. L'homme a le pain, l'enfant a le sel, et nous avons le poivre. 20. Votre frère a-t-il une livre de beurre?

Exercise 4

1. Have you the woollen stocking? 2. No, sir, we have the silk stocking. 3. The physician's sister has a silk dress. 4. The lady's brother has a silk hat. 5. Sir, have you the physician's book? 6. Has he the lady's book? 7. Is your brother warm? 8. He is neither cold nor warm. 9. Is your sister hungry or thirsty? 10. She is not hungry, but thirsty. 11. Is your friend sleepy? 12. My friend is not sleepy. 13. My sister is not afraid. 14. Are you right or wrong? 15. I am never ashamed. 16. Have you milk or wine? 17. Have you handsome cloth and good coffee? 18. We have seen neither tree nor garden. 19. Has the tailor a gold button? 20. The merchant has hats, silk, and cloth.

Key to Exercise 1

1. I have a father and a mother. 2. Good day, monsieur, I shall be at the school to-morrow. 3. Have you a letter? Yes, madam, it is at the house. 4. Give me a newspaper. 5. The young girl will be at the play. 6. We shall have the officer's pen. 7. It is bad weather. 8. The banker's money is always ready. 9. The boy had a book and a pen. 10. Are you ready, sir? 11. Will you have the newspaper next Sunday? 12. The girl's father was at the house. 13. Will you be the baker's friend? 14. No, miss, I shall be the officer's friend. 15. Fear is a bad general. 16. Give me a loaf. 17. The grocer's brother is always ready. 18. The general's mother had a flower. 19. Will she be at the house to-morrow? 20. The banker's daughter and sister will have a portmanteau at the house.

Key to Exercise 2

1. Avez-vous une sœur? 2. Non, j'ai un frère. 3. Seront-ils à la maison demain? 4. Oui, monsieur, et ils auront une lettre de l'officier. 5. La sœur du banquier avait l'argent. 6. Donnez-moi un journal et une plume. 7. Je serai à la guerre dimanche prochain. 8. Le garçon et la fille avaient un pain. 9. La jeune fille a toujours une fleur. 10. Merci, mademoiselle, nous serons au spectacle. 11. La sœur de l'homme aura une plume. 12. L'ami sera à l'école demain. 13. La lettre du général était dans le journal. 14. Le garçon sera l'ami de officier. 15. Le temps était mauvais. 16. La valise de l'homme est dans la maison. 17. La fille de l'épicier est à la maison. 18. La fille avait le pain et l'argent. 19. Le jeune garçon avait une plume. 20. Auront-ils une lettre demain? E. A. B.

Continued from page 107

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

THE EARTH AS A GLOBE

THE ancients thought the earth to be a circular plain surrounded by the River Oceanus, whose outer banks supported the pillars of heaven. Across the arch of heaven coursed the stars—for the edification of mankind! Thus Homer.

Plato (B.C. 347) regarded the earth as a cube; Anaximander (B.C. 547) as a disc-like section of a vertical cylinder. From the notion of Cosmas (550 A.D.), that the earth was a rectangle, we have derived our terms latitude (breadth) and longitude (width), although we do not use them exactly in this sense to-day.

Thales, the Greek scientist (B.C. 546), had, however, declared it to be a sphere. Pythagoras (B.C. 530) agreed with this view. But with the fall of Rome and the lapse of Europe into the ignorance of the Dark Ages, men fell into the ancient error of believing that the earth was disc-shaped. The old "wheel-maps" of the Middle Ages illustrate this notion very well. It was not until the great awakening of the Renascence, and after the work of Copernicus and Galileo, that the world was generally accepted as a sphere. There are incontrovertible proofs of the earth's sphericity.

THE WORLD ACCORDING TO HOMER
was a circular plain surrounded by the River Oceanus, whose outer banks supported the pillars of heaven.

(1) The telescope reveals clearly that the sun, moon, and planets are spheres. There is no reason to suppose that the earth is an exception to the rule.

(2) The shadow of the earth as thrown on the moon during the moon's eclipse has always an edge which is an arc of a circle.

(3) The earth's shape—a sphere slightly bulged at the equator and slightly flattened at the poles—is exactly what a fast-rotating body might be expected to assume when it takes form in a semi-plastic condition.

(4) There are experimental proofs.

(*a*) Incoming ships show their topmasts above the horizon long before the hull is seen. With outward-bound vessels the converse is the case.

(*b*) The horizon is always circular. Further, the higher one ascends the wider

does the horizon become. This is particularly clear at sea. Ten feet above the water gives one a horizon about four miles distant. Ascend to 100 feet, and the horizon recedes to thirteen miles (Fig. 5).

(c) The Bedford Level experiment offers a conclusive proof. (*See* p. 95 ASTRONOMY.)

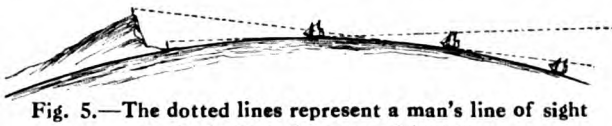


Fig. 5.—The dotted lines represent a man's line of sight to the horizon from two altitudes.

(5) Variation in local time can be accounted for only by the assumption of a spherical earth. If the earth's surface were flat, all places would have noon simultaneously. This is not the case.

The circumference of the earth may be taken as approximately 25,000 miles. Its area is about 200,000,000 square miles. The polar diameter is 7,900 miles; but the equatorial diameter is 7,926 miles, owing to the equatorial bulge.

The earth's volume is estimated at 260,000,000,000 cubic miles, and its weight 6,000,000,000,000,000 tons!

It is important to be able exactly to fix the position of a place on the globe. The position of any point in a plane may be accurately stated by reference to two lines at right angles, and we can apply this principle.

Around the middle of the globe runs the equator. Using this as a line of reference, we can say that a place is so far north or south of it. This, however, fixes the position of the place in one direction only — along a circle which is the given distance from the equator. If, however, we fix the position of the point, with reference to a standard north and south line, as well as to the equator, we have it exactly. This standard line, running from pole to pole, is the Prime Meridian which passes through Greenwich Observatory. Places east of it are said to be in east longitude; places west of it, in west longitude. Similarly, places north of the equator are said to be in north latitude; places south of it, in south latitude.

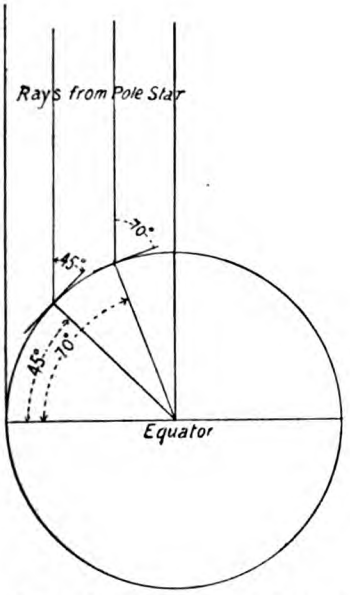


Fig. 6.—The Pole Star is so far from the earth that rays from it to different parts of the earth are parallel. Hence the altitude of the Pole Star—i.e. its distance in degrees above the horizon—from any place can always be taken as the latitude of that place.

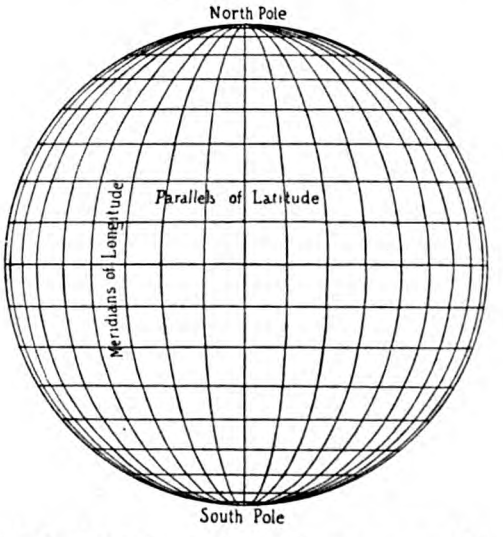


Fig. 7.—Latitude and longitude are measured in degrees. Since the earth is a sphere, and the distance from the equator to the pole a quadrant, latitude varies from 0°–90° N. or S., but longitude from 0°–180° E. or W.

Reference to a globe will show that it is covered with a network of lines, some running in circles parallel to the equator, others running at right angles to them and through the poles. The first are parallels of latitude; the second, meridians of longitude, so called because all places on any meridian have midday at the same moment.

Latitude and longitude are measured in

degrees. Since the earth is a sphere, and the distance from equator to pole a quadrant or quarter of a circle, latitude varies from 0° to 90° north or south. Longitude, however, varies from 0° to 180° east or west, as the case may be. (Fig. 7.)

Note further that meridians form Great Circles passing through the poles; they divide the earth into two equal parts. But the equator is the only parallel of latitude which is a great circle; the rest diminish in size as they near the poles, and are consequently termed Small Circles. The shortest distance between any two points on the globe lies along the arc of the great circle passing through the points.

Lat.	*Miles*	*Lat.*	*Miles*
0°	69·2	50°	44·6
5°	68·9	55°	39·8
10°	68·1	60°	34·7
15°	66·8	65°	29·3
20°	65·0	70°	23·7
25°	62·7	75°	18·0
30°	60·0	80°	12·1
35°	56·7	85°	6·0
40°	53·1	90°	0·0
45°	49·0	—	—

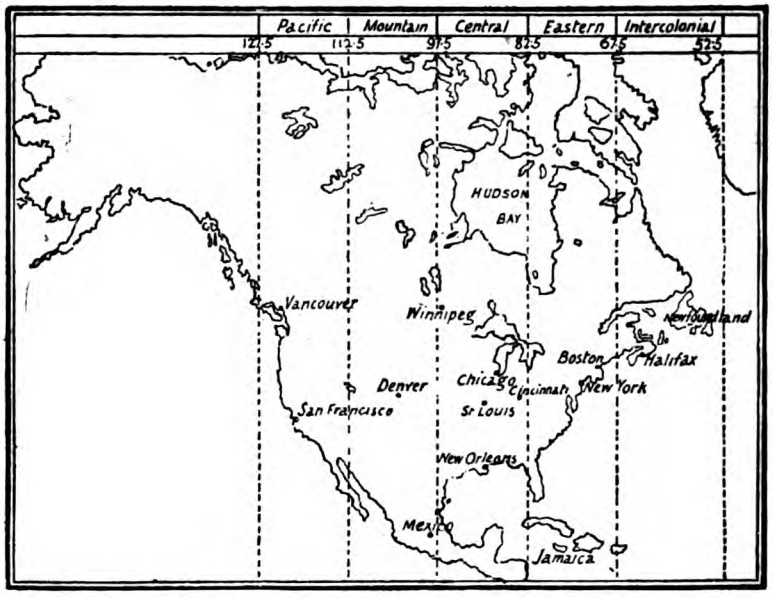


Fig. 8.—In North America, a country which extends over a wide range of longitude, the problem of local time is dealt with by means of five time-belts, each covering 15°, as shown above.

Hence sailors prefer to follow "great circle routes" whenever they can.

Great circles are of the same size—approximately 25,000 miles. Since each is 360° in length, a degree of latitude is $\frac{25000}{360}$ miles long—roughly 69 miles. Degrees of longitude *at the equator* are also about 69 miles long, since the equator is a great circle. In any other latitude, however, a degree of longitude must be less, since it will be measured off along a small circle. A degree of longitude varies from about 69 miles at the equator to 0 miles at the poles. At 60° north and south it is half what it is at the equator. The following table gives the length of 1° longitude for certain latitudes :—

Owing to the slight flattening at the poles 1° latitude measured near there is 68·8 miles, but near the equator it is 69·4 miles.

If we know the latitude and longitude of a place we can easily find its position on the globe. Navigators and explorers can find their latitude by means of instruments from observation of the sun and other heavenly bodies. Longitude they can also calculate by comparison of their local time with Greenwich time. They can then refer to chart or map and find out precisely where they are.

Polaris is a star which would be practically directly overhead to an observer at the North Pole; hence its familiar name, "The North Star" or "Pole Star." It is so far from the earth that rays of light from it to different parts of the earth are practically parallel. To an observer at the equator it would therefore be on the northern horizon; at 45° N. he would see it exactly half-way between the horizon and the zenith (the spot directly overhead), i.e. at 45° from the horizon; at 70° N. he would see it at 70° from the horizon; and so forth. (Fig. 6.)

Hence the altitude of the Pole Star—its distance in degrees above the horizon—is always the latitude of the place. In the southern hemisphere the Pole Star is below the horizon, and is invisible. However, stars near it are used—subject to certain calculations. At sea latitude is usually found by observing with a sextant the

sun's greatest altitude. (*See* ASTRONOMY, p. 220.)

The earth turns on its axis once in 24 hours; that is, it turns through 360° in that time. This is at the rate of 15° per hour.

Since the earth rotates from west to east, places to the east of Greenwich have dawn earlier than Greenwich, while places to the west have dawn later than Greenwich.

Suppose it is noon at Greenwich. Greenwich and all other places in 0° longitude have the sun directly opposite them, appearing at his highest point for the day. At the same moment a place 15° east of Greenwich will have passed its noon an hour ago, and its local time will be 1 P.M.

New York is in long. 74° W. Its time will be behind that of Greenwich by $\frac{74}{15}$ hours, or 4 hours 56 minutes. When London clocks are striking twelve, clocks in New York are at 7.4 A.M.

It is clear, then, that there is a definite relationship between longitude and time. If we know the difference in local time between two places, and we know also the longitude of one of them, it is a simple matter to calculate the longitude of the other.

Countries which cover a wide range of longitude make special arrangements for dealing with local time. In North America, for example, there are five "time-belts," whose local times differ by 15°, as shown in Fig. 8.

In practice these belts have not regular longitudinal boundaries, since the great transcontinental railways have chosen convenient points to make the changes.

Greenwich time is used by Britain, France, Belgium, and Holland; Ireland uses Dublin time—about 25 minutes slower than Greenwich time; Denmark, Germany, Italy, Switzerland, and Scandinavia use mid-European time, one hour faster than Greenwich.

A ship sailing westward round the world sails "with the sun." The ship's chronometer gains steadily each day on comparison with local time, until arriving again at the starting point it registers correct time again, but the ship's calendar is a day out. The ship has lost a day! Similarly, sailing eastward, the ship would gain a day!

To avoid these difficulties, the meridian of 180° W. (opposite 0°) has been fixed as the place of adjustment. It is known as the "Date Line." Ships going east subtract a day from their calendar on crossing the Date Line; ships going west add a day. The Date Line crosses chiefly sea; where it should cross land the line has been diverted, as shown by the dotted line in Fig. 8. R. F.

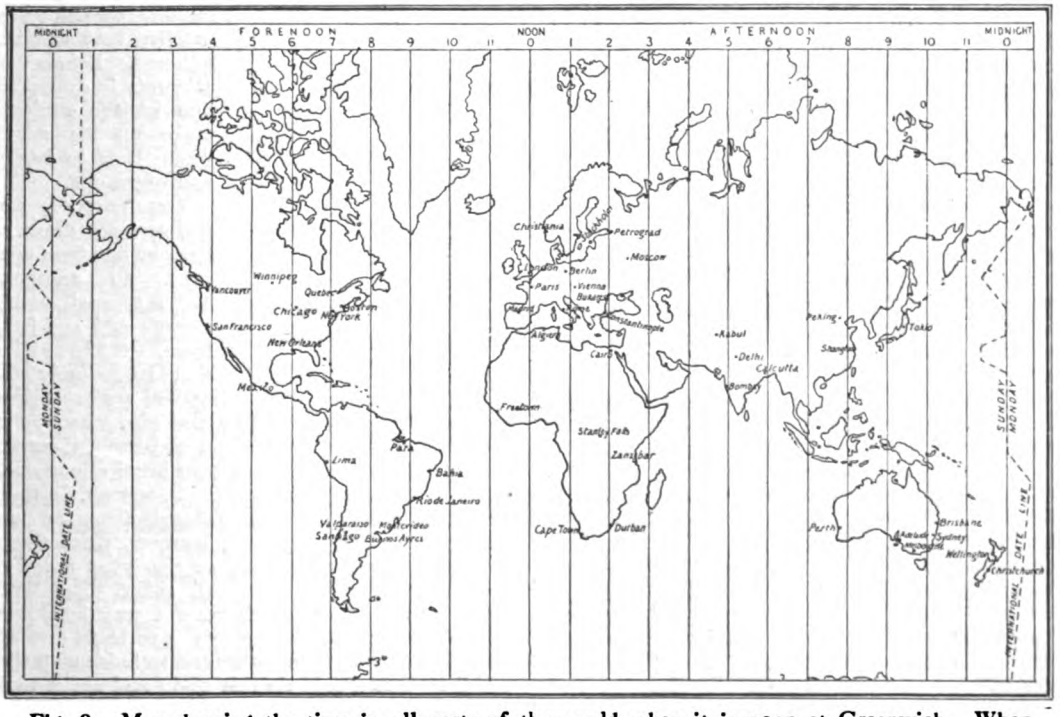


Fig. 9.—Map showing the time in all parts of the world when it is noon at Greenwich. When crossing the "Date Line," ships going east subtract a day from their calendar; ships going west add a day. The "Date Line" (shown dotted) nowhere crosses land: hence its irregular shape.

Continued from page 111.

ART AND MUSIC:

Contributors :—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

DRAWING.—II

Preliminary Exercises.—Every object can be resolved into straight and curved lines. Sometimes the lines are all curved, sometimes—less often—all straight; most often of all a combination of curved and straight lines. It is the points of contact between straight and curved, the amount of curvature and the strict length of the straight lines which presents the first real problem of the draughtsman. Care, deliberation and the inestimable quality of patience are the qualities most necessary to inculcate, and if you have these you will be able to master this question of lines.

I have already described how the pencil should be held with regard to the line. It is now necessary to show how the pencil should be held by the hand itself. In the first place, it is important not to hold the pencil too low down. The ends of the fingers should be at least two inches from the point, preferably a little more.

The pencil should be perfectly comfortable between your fingers, so that whilst you have absolute control over it, you can yet move it easily in any required direction. Real control of your pencil, or rather your hand, is a matter of practice, as already suggested.

By control is meant steadiness, and the power to move your pencil exactly where you want to move it. It is likely enough that at first your line will be far from true; it will be ragged and untidy. This is practically inevitable. The great thing is not to be discouraged by the first few failures, but to go on practising. You will find yourself gradually improving until, at all events, in simple forms, you can be perfectly certain of being the master of your pencil.

The great thing is to make a habit of freedom in the use of the pencil. This can best be acquired by practising it, not only at the times you devote to the study of drawing, but at odd minutes, when you have nothing better to do.

You should always remember the importance of each individual line. To quote the authority mentioned before: "To draw a single line requires the same care and judgment as a combination of any number of lines; each line must be drawn cleanly, and with a knowledge beforehand of its proper position. The same principle that regulates one, regulates the whole; it is only a repetition of that principle according to the number of lines in the drawing." . . . To draw a line at random, without a previous arrangement, trusting more to good luck than to skill for its being correct, and leaving out all consideration or inquiry as to its fitness until it is drawn, is the most discouraging practice that can be followed. Before he attempts to draw the line let the student make up his mind where it is to begin and where end.

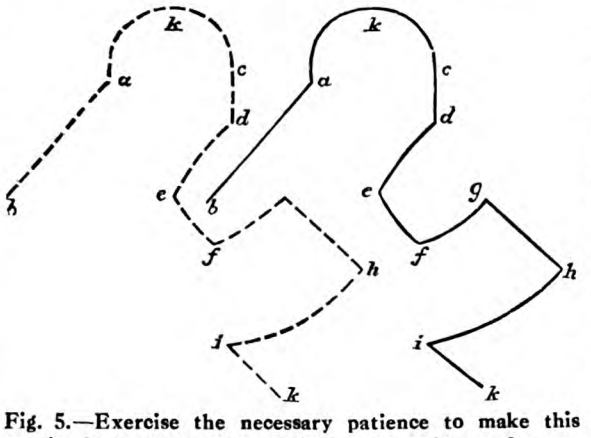


Fig. 5.—Exercise the necessary patience to make this simple but important preliminary drawing perfect.

You purpose, we will say, to draw a straight line from one point to another. Make a small mark at each end and join them. This rule should be closely observed in any case, both when you are practising straight lines by themselves and also when your straight line forms part of an elaborate drawing.

Again, it may happen that your line is a long one. One stroke of the pencil will not be enough. In that case mark points at regular intervals along the line and join them up. Do not, however, place these marks too closely together, or else your practice in drawing straight lines will suffer. The best method to follow when drawing a very long line with the help of marked points is to begin first at one end and then at the other and to finish with the middle. You should do this again and again, and yet again, until you can rely on yourself to be quite accurate. Also, you should practise lines of all sorts in this way, perpendicular, horizontal and

slanting. Remember, too, how important it is to hold the pencil as already described. The same system should be applied to curved lines; only in this case, the marked points should be a great deal nearer together, for the reason that your certainty of direction cannot be so strong.

It has already been said that all objects are made up of straight and curved lines, so a simple exercise made up of mixed lines will be useful. Fig. 5 will explain this. Practise straight and curved lines separately and together and exercise enough patience to make this simple but highly important preliminary to drawing perfect.

Study Fig. 5 carefully, and then reproduce it four or five times as large. Begin at the left hand side with the points *b* and *a*; join these together with a straight line and mark with the pencil the relative positions of *k*, *c*, and *d*, then join these with curved lines. This exercise contains far more than is seen at the first glance and is an excellent example to follow again and again.

Having done this you can, with much advantage, turn to such examples as are given in Figs. 6, 7, 8, 9 and 13. In the same way as before, mark the points just as they are in the illustration. The utmost pains should be exercised to arrange these points with due regard to their distances from, and their positions relative to, each other.

Take the upright pillar in Fig. 6 as an instance. See that *a* and *b* are properly placed in a horizontal line and that *c* and *d* come exactly beneath them. If more points are required between *a* and *c* and *b* and *d*, to help you to get the lines straight, put them in at your own discretion. The same rules apply to the next figure, number 7. In Fig. 9, the greatest help will be derived by roughly marking out a triangle first. The line *a*—*b* will give the right point for the edge of each step. After that the drawing of the actual steps should be quite easy.

Whenever you draw from an object, you should make careful note of the angles made by two meeting lines. Mathematically, with instruments, this is readily done; but you are learning to draw under the control of your eye and hand only. Practice will soon teach you a fine measure of accuracy. Then you should learn to note correctly the length of the lines which make the angles and the exact position of the points where one line intersects another.

Always, before laying pencil to paper, it is necessary to study the object you are going to draw. This cannot be repeated too often. The general outline becomes fixed in the mind's eye, and you will then be more likely to detect the smallest divergence from that outline for yourself.

Symmetrical Patterns.—Fig. 10 is entirely composed of curves, but one point which makes it more difficult for the beginner to copy accurately lies in the fact that the opposite sides are exactly similar. The drawing of the vine leaf, Figs. 11 and 12, irregular as they are, present less trouble.

Fig. 10, or anything having two similar sides, is a discouraging subject, because if you make the smallest mistake and represent one side of the object in the least different from the other, you see it at once—and the beginner cannot fail to make mistakes at first. For this very reason such an exercise is in the highest degree important. You will constantly be called upon to draw symmetrical patterns, and, naturally, you *must* learn to draw them accurately. So you cannot too often repeat

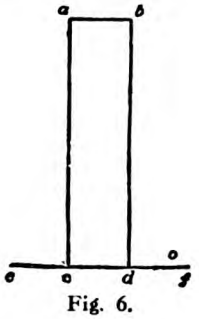


Fig. 6.

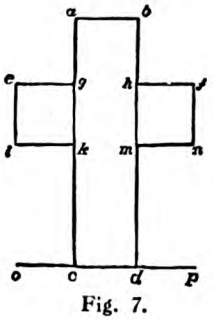


Fig. 7.

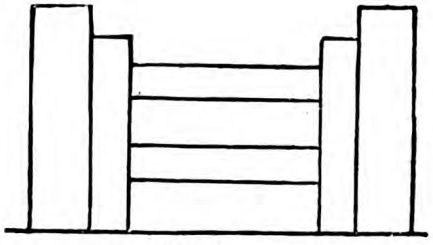


Fig. 8.

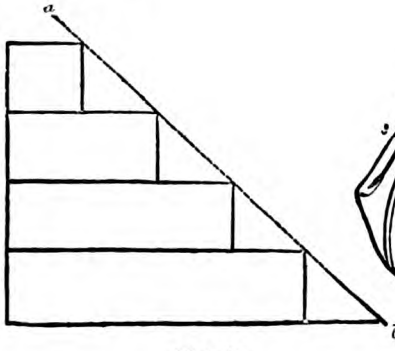


Fig. 9.

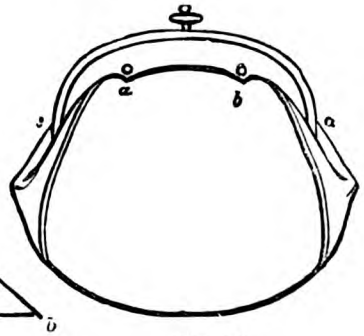


Fig. 10.

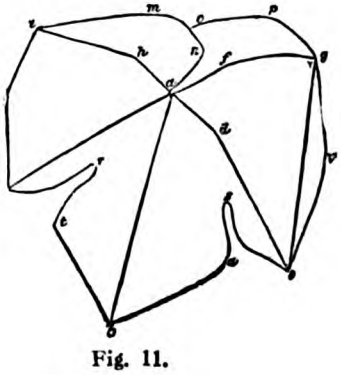


Fig. 11.

such an exercise, however simple the object copied may be.

Now study the vine leaf. Fig. 11 shows how the distances may be marked out at the beginning. In doing this, you will be well advised to start at the middle, the point *a*. Then mark in the distance and position of *b*, which is the extreme point of the leaf. Notice that the line *a*—*b* is *not* perpendicular, and then join them. Then move on to *c* and join

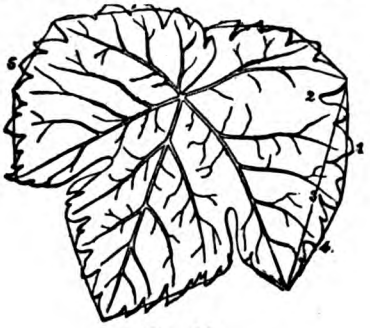


Fig. 12.

that with *a*. Where two points have to be joined up with *a*, which are not in a straight line, mark the two new points first, and join them together before producing your line to *a*. Take first all the points radiating from the middle *a*, join these to *a*, and then trace from point to point the outline of the whole leaf.

When you have got the outline right and the essential lines within the design, which make up

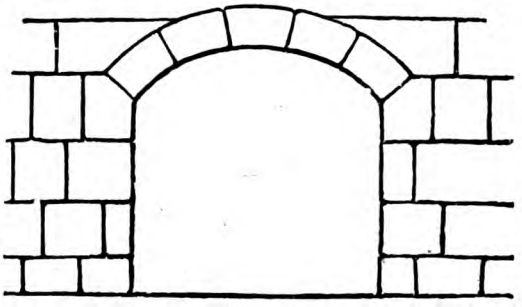


Fig. 13.

the skeleton of the leaf, you should partially rub out the whole, so that the lines just remain visible. This process is known as "fainting" the lines.

You then draw a firm finished outline and mark in the detail. In this again you can help yourself by marking out positions before you actually draw the lines. As you copy from these figures, watch them both, particularly when you come to add the detail as shown in Fig. 12. But it is in outline that you must first make yourself proficient; until you can draw outline you will never be able to draw anything. Therefore, you should go on practising outline with occasional simple detail until you are quite sure of yourself. Shading, for example, can well be left for the present. Certainty of touch and control of hand are much more important at the beginning.

J. G. B. L.

STORY PICTURES

A GOOD picture which tells a story is not nearly so good as a good picture which does not tell a story. It has already been said that you should guard against the extrinsic appeals made by pictures whose subjects interest you. This was mentioned particularly in regard to portraits, but the same thing may equally well be said of any subject.

We can all, probably, think of many pictures—popular pictures—that tell a definite story—that is the very reason of their popularity. Sometimes such a picture may be of the most admirable quality, such as Hogarth's "Marriage Contract" and "After the Marriage," and other Hogarth paintings. But Hogarth is a law unto himself. As an artist he has had many imitators, but he has never had an equal.

The modern story picture is often quite extraordinarily commonplace. The subject really does not matter one whit; but naturally a homely, everyday sort of scene will appeal to the largest number of people, and so the thing becomes popular.

The Commonplace in Art

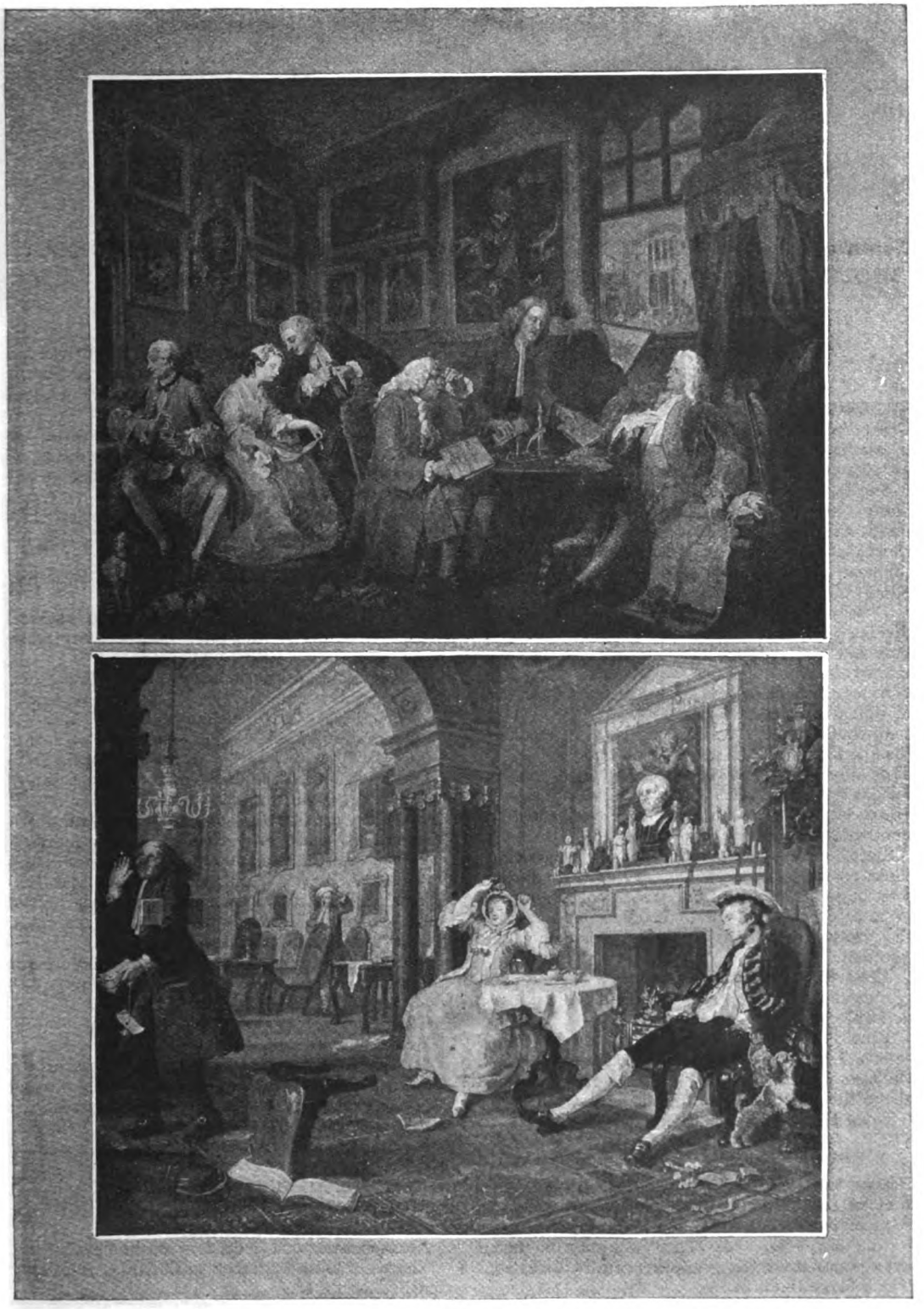
Now, the largest number of people do not know very much about art, so the consequence is that the output of commonplace scenes by commonplace means becomes amazingly large. A good artist, on the other hand, treats a homely or commonplace scene in such a way that the picture is distinguished and lifted far above the average.

And you then admire the picture, not the story in the picture, which matters very little.

In the same way, to employ an allowable analogy, a connoisseur of good writing looks for good writing in a book before he looks for a good story in the book. Though in this case the story and the means of producing it are together less easily separable in the art of writing than they are in the art of painting. But, as said already, in painting, a story is not necessary at all.

A man draws a face or a flower or a mountain. He wants to produce these things as he sees them, with all the hidden meaning in the face, the subtle colour in the flower, and the grimness and perhaps mystery of the mountain, as he feels these things himself. That is not telling a story, or, if it is, it is telling a not very obvious one.

J. G. B. L.



"THE MARRIAGE CONTRACT" AND "AFTER THE MARRIAGE."

Two of the incomparable "story pictures" of William Hogarth (1697-1764), the founder of the British School of painting.

Continued from page 119.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—III

Division

23. Division is a method of finding how many times one number, called the **divisor,** is contained in another number, called the **dividend.** The result is called the **quotient.**

For instance, to divide 15 by 5 is to find how many times 5 is contained in 15. We may also put it this way: (1) How many times is 5s. contained in 15s. ? The quotient will be 3 times. Or (2) how many shillings are contained 5 times in 15s. ? The quotient will be 3 shillings.

Division is called **simple** when the divisor and dividend are both abstract numbers, or concrete numbers of the same denomination. It is called **compound** when either the dividend, or both the divisor and the dividend, are made up of numbers of different denominations.

If the divisor and dividend both be abstract, then the quotient is an abstract number. If the divisor and dividend both be concrete, then the quotient is again abstract. But if the divisor be abstract and the dividend concrete, then the quotient is concrete.

Since the dividend contains the divisor as many times as there are units in the quotient, division may be looked upon as the reversal of the process of multiplication, for the dividend is a product the factors of which are the divisor and the quotient.

The sign $\div$, **divided by,** placed before a number means that that number is to be used as a divisor.

Thus, $15 \div 5 = 3$ is read, 15 divided by 5 equals 3. The sign / is often used instead of $\div$. Division is also denoted by writing the dividend above the divisor with a line in between.

Thus, 15/5 means 15 divided by 5;

$\frac{15\text{s.}}{5\text{s.}} = 3$; $\frac{15\text{s.}}{5} = 3\text{s.}$

Note that division may be looked upon as a kind of subtraction. How many times may 5s. be taken from 15s. ? 15s. − 5s. = 10s. ; 10s. − 5s. = 5s. ; 5s. − 5s. = 0. Thus, 5s. may be taken three times from 15s. ; in other words, 5s. is contained three times in 15s.

It is not always the case that one number is exactly divisible by another. Thus, if we try to divide 12 by 5 we find that 12 contains 5 twice and that there are 2 over (since $2 \times 5 = 10$, and $12 - 10 = 2$). The number that is left over is called the **remainder.** One number is exactly divisible by another when it is divisible without a remainder.

It follows from this that the product of the divisor and the quotient plus the remainder is equal to the dividend, i.e. **divisor × quotient + remainder = dividend.**

Thus, if the divisor is 5 and the quotient is 2 and the remainder is 2, the dividend is $5 \times 2 + 2 = 10 + 2 =$ **12.**

Being given any three of the above quantities, we can always find the fourth.

24. A number which cannot be separated into two factors each greater than unity is called a **prime** number.

All numbers are divisible by unity. Thus, 2, 3, 5, 7 are prime numbers, $\because 2 = 1 \times 2$, $3 = 1 \times 3$, $5 = 1 \times 5$, $7 = 1 \times 7$; but 4, 6, 8, 9 are not prime numbers, for although $4 = 1 \times 4$, $6 = 1 \times 6$, $8 = 1 \times 8$, and $9 = 1 \times 9$, we may split these up into other factors, each greater than unity: $4 = 2 \times 2$, $6 = 2 \times 3$, $8 = 2 \times 4$, $9 = 3 \times 3$. These latter are often called **composite** numbers. The student must note that composite numbers may often be split into more than two factors ; thus, $8 = 2 \times 4 = 2 \times 2 \times 2$, since $4 = 2 \times 2$.

When a number is split up into factors, each of which cannot be further split up, these are called the **prime factors** of the number.

Consider the number 18. We may factorise it in the following ways: (1) $18 = 2 \times 9$; (2) $18 = 3 \times 6$; (3) $18 = 2 \times 3 \times 3$.

The prime factors are 2, 3, 3.

25. Examples of Division.

(1) Divide 87564 by 9. This is done in the following way, by finding separately the number of units of the different orders, beginning with the highest; 87564 = 87 thousand and 564. Now 81 is the nearest number lower than 87 which is exactly divisible by 9.

$9 \times 9 = 81$ and $81 + 6 = 87$

$\therefore$ 87564 = 81 thousand + 6564
= 9 times 9000 + 6564.

Next consider 6564: 6564 = 65 hundred + 64.

The next lowest number to 65 which is exactly divisible by 9 is 63.

$9 \times 7 = 63$ and $63 + 2 = 65$

$\therefore$ 6564 = 6300 + 264 = 9 times 700 + 264.

264 = 26 tens and 4, and the next lowest number to 26 which is exactly divisible by 9 is 18.

$9 \times 2 = 18$ and $18 + 8 = 26$
$\therefore 264 = 180 + 84 = 9$ times $20 + 84$.

The next lowest unit to 84 which is exactly divisible by 9 is 81.

$9 \times 9 = 81$ and $81 + 3 = 84$
$\therefore 84 = 81 + 3 = 9$ times $9 + 3$.

Hence we see 87564 = 81 thousand + 63 hundred + 18 tens + 81 units + $3 = 9 \times 9000 + 9 \times 700 + 9 \times 20 + 9 \times 9 + 3$. The last figure 3 is not divisible by 9, and is left over and called the remainder. If we divide each of the other parts by 9 we find the quotient, which is 9000 + 700 + 20 + 9, and this may be written 9729. Thus, if we divide 87564 by 9, we get a quotient 9729 and a remainder 3.

The above is usually called short division, and is written as follows:

9) 87564
9729 and 3 over.

The student in performing such a division would say: 9 into 87 goes 9 times and 6 over, 9 into 65, 7 times and 2 over, 9 into 26, twice and 8 over, 9 into 84, 9 times and 3 over.

We give one more example. Divide 423 by 7. 7 into 42, 6 times exactly; 7 into 3 goes no times and 3 over.

7) 423
60 and 3 over.

All division by numbers from 2 to 12 should be performed in this way, which is perfectly easy as soon as the student thoroughly knows his multiplication tables.

(2) To divide 4758 by 10:

Since $10 \times 475 = 4750$, the quotient obviously is 475 and there are 8 over.

Similarly, to divide 4758 by 100:

Since $100 \times 47 = 4700$, the quotient is 47 and there are 58 over.

(3) Divide 2544780 by 6972.

```
6972 ) 2544780 ( 365
       20916
       -----
        45318
        41832
        -----
         34860
         34860
         -----
```

The method employed is as follows: Mark off from the left hand of the dividend the least number of figures which is not less than the divisor; then find by the multiplication table how many times the left-hand figure of the divisor goes into the left-hand figure of the dividend; if the latter is less than the former, as in the above case where 2 is less than 6, find out how many times the left-hand figure of the divisor goes into the first 2 left-hand figures of the dividend, and place the figure denoting the number of times in the quotient. In our case 6 goes 4 times into 25, but we shall find that the product of 4×6972 is greater than 25447, and therefore instead of 4 we place in the quotient 3, the next smaller figure. We write down the product of 3 and 6972 and subtract it from the figures marked off in the dividend. To the right of this remainder we place the next figure of the dividend and repeat the process until we have brought down the last figure of the dividend. We shall then have found the quotient, and the remainder if there be one.

26. Long division may be much shortened in the following way. We have at each stage to subtract a multiple of the divisor from the dividend. This may be done figure by figure.

Divide 7514 by 23.

```
23 ) 7514 ( 326
       61
      154
       16
```

The first figure of the quotient is 3 and is obtained by finding how often 23 is contained in 75.

We must now subtract 3 times 23 from 75, figure by figure, thus: 3 times 3 are 9, 9 and **6** are 15, write the 6 under the 5 and remember to carry 1 ten from 15; 3 times 2 are 6 and 1 make 7; 7 and **0** are 7, but since this 0 would be the last figure on the left we need not put it down. Now bring down the 1. The next figure of the quotient is found by discovering how often 2 is contained in 6. This would be 3 times, but we should find that $3 \times 23 = 69$, which is > 61, $\therefore$ the second figure in the quotient must be 2.

We must now subtract 2 times 23 from 61. Twice 3 are 6, 6 and **5** are 11; put 5 under the 1 and carry 1 ten from the 11. Twice 2 are 4 and 1 are 5, 5 and **1** are 6, put down 1 under the 6. Bring down the 4. The third figure of the quotient is found in the same way as the others; it is 6. Subtract 6×23 from 154; 6×3 are 18 and **6** are 24, put down the 6 under the 4 and carry 2 tens from the 24. 6×2 are 12 and 2 (carried) are 14 and **1** are 15. Put the 1 under the 5. The division is now finished; the quotient is 326 and the remainder is 16.

The next example is longer, and the student should write out the working for himself. The first figure of the quotient is written over the last figure of the group of figures on the left of the dividend first considered. This helps to guide the eye and the remaining figures of the dividend need not actually be brought down.

Divide 7964813 by 5245.

```
          1518
          ----
5245 ) 7964813
       2719
        973
       4486
       2903
```

The quotient is 1518 and the remainder is 2903.

27. When the divisor can be split up into factors it is often easier to divide by short division by one factor, and then divide the result by the other factor. If there be a remainder in each case, the true remainder is found by multiplying the second remainder by the first divisor and adding the first remainder to the product.

Examples:

(1) Divide 7549 by 48.

```
48 { 8 | 7549
   { 6 |  943 eights and 5 units over
       -----
       157 forty-eights and 1 eight over.
```

The total remainder is 1 eight and 5 units, i.e. 13. Thus the quotient is 157 and the remainder 13.

We may demonstrate the truth of this as follows:

7549 = 8 times 943 together with 5,
and 943 = 6 times 157 together with 1.
∴ 7549 = 8 times (6 times 157 + 1) together with 5
= 48 times 157 + 8 + 5
= 48 times 157 + 13.

(2) Divide 12763 by 126. Here the divisor may be split into 3 factors, for 126 = 2 × 7 × 9.

126	2	12763	
	7	6381 and 1 unit over	= 1
	9	911 and 4 twos over	= 8
quotient = 101 and 2 fourteens over			= 28
		remainder	= 37

The reasoning is the same as above.

forty-seven thousand six hundred and fifty-three. (13) Four thousand three hundred and twenty-one million nine hundred and eighty-seven thousand six hundred and fifty. (14) Eight hundred and ninety-seven thousand eight hundred and ninety-seven million eight hundred and ninety-seven thousand eight hundred and ninety-seven. (15) Sixty-nine billion seven hundred and forty-three thousand five hundred and eighty-two million two hundred and eleven thousand and five. (16) Eleven billion eleven million and eleven.

Key to Exercise 2

(1) XVII. (2) DXCIII. (3) CI. (4) LXXXIX. (5) CCCCLIV. (6) MDCCLXIII (7) 14. (8) 38. (9) 245. (10) 72. (11) 650. (12) 1,869.

Key to Exercise 3

(1) 15,997. (2) 5,112,604. (3) 993,057,260. (4) 2,925,620.

Do You Know That

one crown weighs one ounce; three pennies weigh one ounce; and five shillings weigh one ounce?

Exercise 7

Divide—

(1) 204 by 17. (2) 473 by 21. (3) 98745 by 117. (4) 859482 by 231. (5) 7849102 by 4751. (6) 38904165 by 90192.

Divide by factors—

(7) 57613 by 175. (8) 1074182 by 216. (9) 748915 by 105. (10) 6490201 by 144.

Using the method of § 28, divide—

(11) 1984001 by 239. (12) 112440597 by 6743. (13) 505790841 by 70912. (14) 1000950000 by 2200753. (15) How many times can 11 be subtracted from 1000000?

Key to Exercise 1

(1) 400,000. (2) 437. (3) 4,037. (4) 400,037. (5) 4,003,709. (6) 9,009. (7) 28,743,913. (8) 202,202,202. (9) Seven hundred and three. (10) Seven thousand and three. (11) Seven hundred thousand and three. (12) Fifty-nine million

(5) (*a*) 34; (*b*) 24,156. (6) (*a*) 373,749; (*b*) 4,287,735; (*c*) 18,230,640; (*d*) 11,124,381,709.

Key to Exercise 4

(1) (*a*) 14; (*b*) 44; (*c*) 29; (*d*) 104,573; (*e*) 1,021; (*f*) 899,900. (2) (*a*) 15,963,269; (*b*) 556,336,919; (*c*) 23,456,790; (*d*) 864,197,532. (3) 206,775,093 5,086,746,668 9,000,900,901.

Key to Exercise 5

(1) A pays B £77, C pays B £140, and D pays B £22. (2) 74. (3) 169. (4) 8,739.

The Use of Keys

In using keys, it should be remembered that their object is to help the beginner in his first efforts rather than to absolve him from being as accurate and as careful as possible. Reference must not be made to them before the sum — or better still — the whole exercise is completed. M. A. L.

ALGEBRA.—III

24. In the course on Arithmetic the student will have learnt, in connection with the multiplication of fractions, the following definition:

To multiply one number by a second is to do to the first what is done to unity to obtain the second.

Thus, $+3 = +1+1+1$

$\therefore (+4)\times(+3) = +4+4+4 = +12$ ... (i)

or $(+4)\times(+1+1+1) = +4\times1+4\times1+4\times1$ ... (ii)

Hence multiplication by a positive multiplier is really a contracted method of addition.

We may regard multiplication by a negative multiplier as a contracted method of subtraction.

Thus, $-3 = -1-1-1$

$\therefore (+4)\times(-3) = -(+4)-(+4)-(+4)$

$= -4-4-4 = -12$ ... (iii)

or $(+4)\times(-1-1-1) = -4\times1-4\times1-4\times1$ ... (iv)

Also $(-4)\times(+3) = +(-4)+(-4)+(-4)$

$= -4-4-4 = -12$ ... (v)

or $(-4)\times(+1+1+1) = -4\times1-4\times1-4\times1$ ... (vi)

And $(-4)\times(-3) = -(-4)-(-4)-(-4)$

$= +4+4+4 = 12$ ... (vii)

or

$(-4)\times(-1-1-1) = +4\times1+4\times1+4\times1$ ... (viii)

The equations (i), (iii), (v), (vii) give us the following rule:

To find the product of two algebraic quantities, find the product of the absolute value of the factors and prefix the positive sign if both the factors are positive, or both are negative; prefix the negative sign if one factor is positive and the other factor is negative.

Thus, $(+a)\times(+b) = +ab$

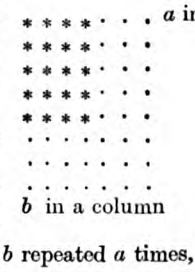
$(+a)\times(-b) = -ab$

$(-a)\times(+b) = -ab$

$(-a)\times(-b) = +ab.$

25. The student has learnt in Arithmetic that in a series of multiplications of whole numbers or fractions, the order in which the operations are performed is immaterial. We now proceed to prove that in Algebra the factors of a product may be taken in any order.

Consider the following arrangement of dots, a in a row and b in a column, where $a \times b$ are any integers. If we consider the rows, the whole number of dots is a repeated b times, that is $a \times b$. And if we consider the columns, the whole number of dots is b repeated a times, that is $b \times a$. Hence $ab = ba$.



Now, we know that if we have to deal with fractions, say $\frac{3}{4}\times\frac{5}{8}$, that $\frac{3}{4}\times\frac{5}{8} = \frac{3\times5}{4\times8}$.

By the above proof for integers, $\frac{3\times5}{4\times8} = \frac{5\times3}{8\times4} = \frac{5}{8}\times\frac{3}{4}$, i.e. $\frac{3}{4}\times\frac{5}{8} = \frac{5}{8}\times\frac{3}{4}$.

Hence we conclude that $ab = ba$ for all positive integral and fractional values of a and b.

But it is clear from what was proved in § 24 that this must also hold for negative values of a and b, since the absolute value of the product is independent of the signs.

Hence for **all values** of a and b,

$$ab = ba \quad . \quad . \quad . \quad . \quad \text{(i)}$$

If in the above diagram we put c in place of each dot, the whole number of c's will be ab; also the number of c's in the first row will be a, and this is repeated b times. Hence, when a and b are integers, c repeated ab times gives the same result as c repeated a times and this repeated b times. Thus we see that **to multiply by any two whole numbers in succession is the same as to multiply by their product.**

As before, we can extend this to fractional and negative values; hence we conclude that for all values of a, b, and c,

$$a\times b\times c = a\times(bc) \quad . \quad . \quad . \quad \text{(ii)}$$

Now, from (i) $a\times(bc) = a\times(cb) = a\times c\times b$

$\therefore a\times b\times c = a\times c\times b$

i.e. $abc = acb$.

Thus by a continued application of (i) and (ii) we can show that

$$abc = bca = cab = cba, \text{ etc.}$$

Equations (i) and (ii) represent the Laws of Commutation and Association respectively, for Multiplication.

26. We have proved that the factors of a product can be taken in any order. It follows, therefore, since division is the inverse of multiplication, that in a series of divisions the order in which the operations are performed is immaterial.

Thus $a\div b\div c = a\div c\div b \quad . \quad . \quad \text{(i)}$

It also follows that **to divide by two or more quantities in succession** is the same as dividing by their product.

Thus $a\div bc = a\div(b\times c) = a\div b\div c \quad \text{(ii)}$

Further, in a series of multiplications and divisions the order of operation is immaterial.

Consider $a\times b\div c$.

$a = a\div c\times c$ by the mutual inverseness of multiplication and division

$\therefore a\times b = a\div c\times c\times b$

$= a\div c\times b\times c$

$\therefore$ dividing each side of the equation by c,

$a\times b\div c = a\div c\times b\times c\div c$

$= a\div c\times b$ by the mutual inverseness of multiplication and division.

Thus we get the same result whether we first multiply a by b and then divide by c, or first divide a by c and then multiply by b, or first divide b by c and then multiply by a.

Equations (i) and (ii) represent the Laws of Commutation and Association respectively, for Division.

Thus we may state the **Law of Commutation for Multiplication and Division** as follows:

In a series of multiplications and divisions the order of operations is immaterial provided the proper sign remain attached to each operand.

And the **Law of Association for Multiplication and Division** as follows:

A series of multiplications and divisions associated into a single operand by means of a bracket, may be dissociated by removing the bracket, and leaving the signs × and ÷ unchanged if the bracket be preceded by the sign +, and reversing the signs × and ÷ if the bracket be preceded by the sign −.

We may here point out that the laws of signs for the division of algebraic quantities follow from the corresponding laws for multiplication.

Examples:—

$+ (a \div b) \times (-b) = -\{(a \div b) \times b\}$ by the law of signs for multiplication

$= -\{a \div b \times b\}$

$= -\{a\}$ by the mutual inverseness of multiplication and division

$= -a.$

Hence if b be any finite quantity other than 0,

$$+ (a \div b) \times (-b) \div (-b) = (-a) \div (-b);$$

and since $\times (-b) \div (-b)$ are mutually inverse,

$$+ (a \div b) = (-a) \div (-b),$$

or, reversing the two sides of the equation,

$$(-a) \div (-b) = + (a \div b).$$

In like manner we may establish the other cases, and we have

$$(+a) \div (+b) = + (a \div b)$$
$$(+a) \div (-b) = - (a \div b)$$
$$(-a) \div (+b) = - (a \div b)$$
$$(-a) \div (-b) = + (a \div b).$$

27. Consider next in multiplication the case in which the multiplier is an algebraic sum, say $+ 7 - 4$.

Referring back to § 24, we may interpret the operation of multiplying $+ 4$ by $+ 7 - 4$ as follows: add 4 seven times and subtract 4 four times.

Thus $(+4) \times (+ 7 - 4) = + 4 \times 7 - 4 \times 4.$

Similarly $(-4) \times (+ 7 - 4) = - 4 \times 7 + 4 \times 4.$

If we take these two equations in conjunction with the equations (ii), (iv), (vi), (viii) in § 24, we get the following **rule for multiplying an algebraic quantity by an algebraic sum.**

Write down all the partial products formed by multiplying the multiplicand by each term of the multiplier, and determine the sign in each case by the law of signs (given in § 24) for the multiplication of algebraical quantities.

Thus in general symbols we have

$$(+x)(+a - b + c - d) = + ax - bx + cx - dx$$
$$(-x)(+a - b + c - d) = - ax + bx - cx + dx.$$

Next consider the case in which the multiplicand is an algebraic sum. We have

$$(+7-4) \times (+3) = +(+7-4)+(+7-4)+(+7-4)$$
$$= + 7 - 4 + 7 - 4 + 7 - 4$$
$$= + 7 + 7 + 7 - 4 - 4 - 4$$

by the laws of association and commutation for algebraic sums.

Hence $(+7-4) \times (+3) = +7 \times 3 - 4 \times 3.$

Similarly $(+7-4) \times (-3) = -7 \times 3 + 4 \times 3.$

Consequently, **to find the product of an algebraic sum multiplied by an algebraic quantity,** write down all the partial products formed by multiplying each term of the multiplicand by the multiplier, and determine the sign in each case by the law of signs for the multiplication of algebraic quantities.

Thus in general symbols

$$(+ a - b + c - d) \times (+x) = ax - bx + cx + dx$$
$$(+ a - b + c - d) \times (- x) = - ax + bx - cx + dx.$$

28. Lastly, let us consider the case in which both multiplier and multiplicand are algebraic sums, say $(+ x - y + z) \times (+ a - b)$.

First consider the multiplicand as a single operand

$$+ (+ x - y + z).$$

Then by what has gone before,

$$+(+ x - y + z) \times (+ a - b)$$
$$= +(+ x - y + z) \times a - (+ x - y + z) \times b.$$

Again, by what has gone before, since $(+ x - y + z) \times a = (+ x - y + z) \times (+ a)$ we have

$$(+ x - y + z) \times a = ax - ay + az$$
and $(+ x - y + z) \times b = bx - by + bz$
and $- (+ x - y + z) \times b = - bx + by - bz$
$\therefore + (+ x - y + z) \times (+ a - b)$
$= + (+ x - y + z) \times a - (+ x - y + z) \times b$
$= ax - ay + az - bx + by - bz.$

Hence we get the following, which is called the **Law of Distribution for Multiplication.**

To multiply one algebraic sum by another, write down all the partial products obtained by multiplying each term of the multiplicand by each term of the multiplier, determining the sign of each partial product by the law of signs for the multiplication of algebraic quantities.

29. We must now examine in how far the **Law of Distribution** applies to Division.

Consider $(a \div x - b \div x + c \div x) \times (+ x)$, where x is any quantity other than 0.

$$(a \div x - b \div x + c \div x) \times (+ x)$$
$$= + (a \div x) \times x - (b \div x) \times x + (c \div x) \times x$$
$$= a - b + c.$$

If now we divide each side of this equation by $+ x$ we have, since $\times (+ x) \div (+ x)$ are mutually inverse operations,

$$(a \div x - b \div x + c \div x) = (a - b + c) \div (+ x),$$

or, reversing the sides of the equation,

$$(a - b + c) \div (+ x) = + (a \div x) - (b \div x) + (c \div x).$$

Similarly we can show that

$$(a - b + c) \div (- x) = - (a \div x) + (b \div x) - (c \div x).$$

Thus we have the following rule:

To divide an algebraic sum by an algebraic quantity, write down all the partial quotients obtained by dividing each term of the dividend by the divisor, and determine the sign in each case by the law of signs for the division of algebraic quantities.

Note that the divisor cannot be distributed in this way.

Key to Exercise 2

(1) (*a*) + 1. (*b*) − 1. (*c*) + 12. (*d*) − 4. (*e*) −12. (*f*) − 6. (*g*) − 22.

(2) + 4. (3) − 4. (4) 2 − (4 − 7). (5) − 2·5 inches. (6) − 2.

M. A. L.

GEOMETRY.—II

Proposition 1.—Theorem

The two angles which one straight line makes with another straight line on one side of it are together equal to two right angles.

Let C O make ∠s α and β with A B as in Fig. 1.

It is required to prove that α + β = 2 rt. ∠s.

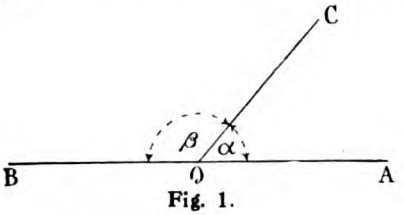


Fig. 1.

Proof.—Suppose a str. line starting in the position O A revolves counter clockwise round O till it reaches the position O B. It will have turned first through the ∠ α and then through the ∠ β. In so doing it will have made half a revolution, i.e. it will have revolved through 2 rt. ∠s.

∴ α + β = 2 rt. ∠s.

Alternative Proof.—Suppose α = β, then each of them = a rt. ∠

∴ α + β = 2 rt. ∠s.

But if α does not = β. Then suppose O D is ⊥ to

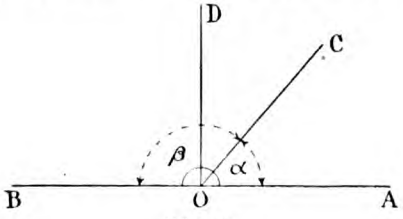


Fig. 2

A B (Fig. 2). Then the sum of α + β fits exactly the sum of ∠s A O D, D O B

∴ α + β = ∠ A O D + ∠ D O B

but each of the ∠s A O D and D O B = a rt. ∠

∴ ∠ A O D + ∠ D O B = 2 rt. ∠s.

∴ α + β = 2 rt. ∠s.

Definitions.—If the sum of two angles be a right angle, then each angle is called the **Complement** of the other.

If the sum of two angles be two right angles, then each angle is called the **Supplement** of the other.

A **Corollary** to a proposition is an additional theorem which is easily seen to be true when the proposition has been proved.

Corollaries to Proposition 1

(1) *All right angles are equal.*

If the student draw any other figure with a line $O_2 D_2$ ⊥ to a line $A_2 O_2 B_2$, he will find that this fig. can be placed on Fig. 2 so that each of the rt. ∠s of this one fits exactly on the rt. ∠s of the other.

(2) *From a point in a straight line only one straight line can be drawn on one side of it and at right angles to it.*

In Fig. 2 imagine that both O C and O D are ⊥ to A B.

then ∵ O C is ⊥ to A B, α = A O D and each = a rt. ∠,

and ∵ all rt. ∠s are equal ∴ α will fit exactly on the rt. ∠ A O D

but one arm A O of α is also an arm of ∠ A O D

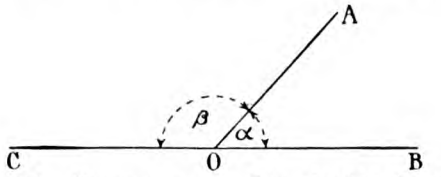
∴ the other arm O C will coincide with the arm O D, that is if the line O C is ⊥ to A B, it will coincide in position with O D.

Proposition 2.—Theorem (Converse of Proposition 1)

If at a point in a line two other straight lines on opposite sides of it make the adjacent angles equal to two right angles, then these two straight lines are parts of one and the same straight line.

Let the two str. lines O B, O C meeting the str. line O A at O make the ∠s α, β, on opp. sides of O A together = 2 rt. ∠s.

It is required to prove that B O C is a str. line.



Proof.—Suppose a str. line starting in the position O B rotates round O counter clockwise till it reaches the position O C.

It will have revolved through the ∠ (α + β) which by hypothesis is 2 rt. ∠*.

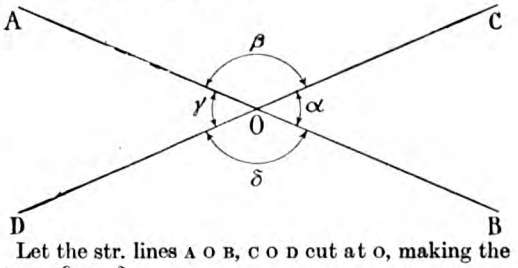
∴ it will have made half a revolution.

i.e. it points in exactly the opp. direction to that in which it pointed at O B.

i.e. B O C is a str. line.

Proposition 3.—Theorem

If two straight lines cut one another the vertically opposite angles are equal.



Let the str. lines A O B, C O D cut at O, making the ∠s α, β, γ, δ.

It is required to prove that α = γ, and β = δ.

Proof.—The str. line O C meets the str. line A B at O.

∴ α + β = 2 rt. ∠s (Prop. 1).

The straight line A O meets the str. line C D at O.

∴ γ + β = 2 rt. ∠s (Prop. 1).

∴ α + β = β + γ.

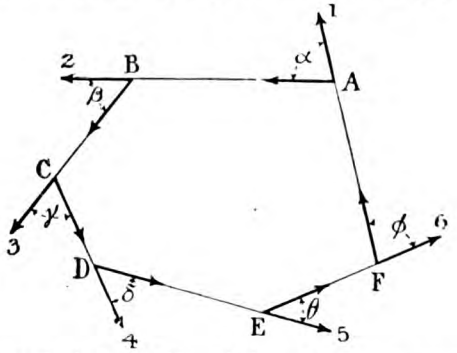
∴ α = γ.

Similarly it may be proved that β = δ.

Proposition 4.—Theorem

If each side of a convex polygon be produced in the same sense, then the sum of the exterior angles thus formed equals four right angles.

Let α, β, γ, δ, θ, φ be the ext. $\angle$s formed



by producing the sides of the polygon A B C D E F in the same sense.

It is required to prove that $\alpha + \beta + \gamma + \delta + \theta + \varphi = 4$ rt. $\angle$s.

Consider a str. line at A in position 1 pointing along F A produced; turn it through the ext. $\angle \alpha$; it then points along A B.

Slide it along without turning to the position 2.

Turn it through the ext. $\angle \beta$; it then points along B C.

Slide it along as before to the position 3 and continue this process until it reaches the position 6, and turn it through φ.

It then points along F A and may be slid along to its original position at 1.

It has turned in the same sense (counter-clockwise) through the $\angle$s α, β, γ, δ, θ, φ in succession. In so doing it has made one complete revolution, i.e. it has turned through 4 rt. $\angle$s.

$\therefore \alpha + \beta + \gamma + \delta + \theta + \varphi = 4$ rt. $\angle$s.

Corollary 1.—*In any convex polygon, the sum of all the interior angles together with 4 right angles, equals twice as many right angles as the figure has sides.*

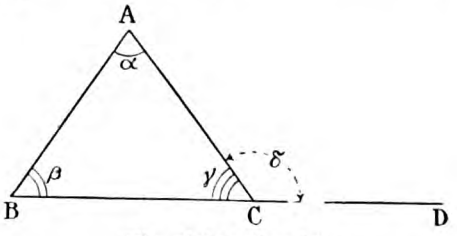


Fig. of Cor. 2 and 3.

At each corner the int. $\angle$ + ext. $\angle$ = 2 rt. $\angle$s (Prop. 1).

$\therefore$ Sum of int. $\angle$s + sum of ext. $\angle$s
= twice as many rt. $\angle$s as there are corners.
= twice as many rt. $\angle$s as there are sides.

$\therefore$ Sum of int. $\angle$s + 4 rt. $\angle$s
= twice as many rt. $\angle$s as the fig. has sides.

Corollary 2.

It follows from this that the sum of the int. $\angle$s of a $\triangle$ + 4 rt. $\angle$s = 2 × 3 rt. $\angle$s.

i.e. the sum of the int. $\angle$s of a $\triangle$ + 4 rt. $\angle$s = 6 rt. $\angle$s.

$\therefore$ the sum of the int. $\angle$s of a $\triangle$ = 2 rt. $\angle$s.

Corollary 3.

Produce the side B C of the $\triangle$ A B C to D, so as to make the ext. $\angle$ δ.

then $\gamma + \delta = 2$ rt. $\angle$s (Prop. 1).

$\gamma + (\alpha + \beta) = 2$ rt. $\angle$s (Prop. 4, Cor. 2).

$\therefore \delta = \alpha + \beta$.

i.e. any ext. $\angle$ of a $\triangle$ = sum of the int. and opp. $\angle$s.

Corollary 4.—Any ext. $\angle$ of a $\triangle$ > either of the int. opp. $\angle$s.

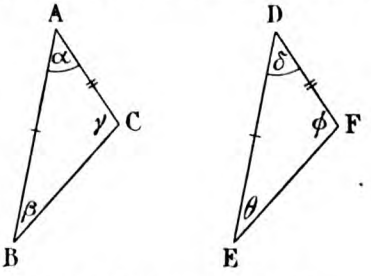
The student should prove Corollary 2 above from first principles, as Prop. 4 has been proved.

Exercise 2

1. In the fig. of Prop. 1, what is the value of β when α has the following values: 15°, 22°, 29°, 35°, 45°, 57°, 66°, 83°?
2. What are the complements of 18°, 25°, 33°, 47°, 49°, 72°, 88°?
3. What are the supplements of 18°, 39°, 52°, 60°, 75°, 90°, 99°, 135°, 142°, 171°?
4. What is the value of the exterior angle formed by producing one of the sides of a regular hexagon?
5. How many degrees are there in each exterior angle of a regular pentagon and how many in each interior angle?
6. Find the number of degrees in an angle of a regular figure of twenty sides.
7. The average size of the interior angles of a convex polygon is 160°: how many sides has it?
8. Two of the interior angles of a triangle are 101° and 39°. What is the third angle?

Proposition 5.—Theorem

If two triangles have two sides of the one equal to two sides of the other respectively, and the included angles equal, the triangles are equal in all respects.



Let A B C, D E F be two $\triangle$s in which

A B = D E
A C = D F And $\alpha = \delta$.

It is required to prove that $\triangle$ A B C $\equiv$ $\triangle$ D E F.

Proof.—Take the $\triangle$ D E F and apply it to $\triangle$ A B C (this may be done by cutting it out, or tracing it, or simply by imagining it to be moved).

Place it so that the pt. D falls on the pt. A and the side D E lies along the side A B.

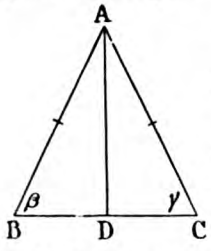
Then $\because$ D E = A B $\therefore$ the pt. E will fall on the pt. B, and $\because$ $\delta = \alpha$ and the arm D E of δ coincides with the arm A B of α,

$\therefore$ the arm D F of δ will lie along the arm A C of α.

But D F = A C ∴ the pt. F will fall on the pt. C.
And ∵ the ends E and F of the str. line E F coincide with ends B and C of the str. line A C,
∴ the str. line E F coincides with the str. line A C.
i.e. the △ D E F coincides with the △ A B C.
i.e. the △s are equal in all respects.
i.e. B C = E F, β = θ, γ = φ.
and the △s are equal in area.

Proposition 6.—Theorem

In an isosceles triangle, the angles opposite to the equal sides are equal.



Let A B C be an isosceles △ having A B = A C.

It is required to prove that β = γ.

Proof.—Suppose A D is a li e which bisects (divides into two equal parts) ∠ B A C and cuts B C at D.

Then in △s A B D, A C D
A B = A C (hypothesis)
A D = A D (identical)
included ∠ B A D = included ∠ C A D (construction).
∴ △ A B D ≡ △ A C D (Prop. 5).
i.e. β = γ.

(**Note.**—We can find the bisector of ∠ B A C by folding the △ A B C so that A C coincides with A B. Then the line A D formed by the crease bisects ∠ B A C, for the part C A D fits exactly the part B A D.)

Corollary.—*If the equal sides of an isosceles triangle be produced beyond the third side or base, then the exterior angles thus formed are equal.*

Suppose the equal sides A B, A C are produced to P and Q respectively.

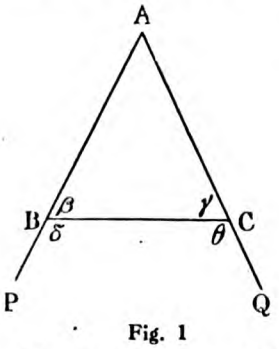


Fig. 1

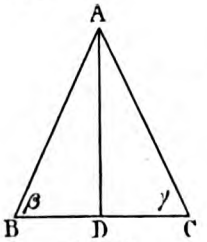


Fig. 2

To Prove that δ = θ (Fig. 1).
β + δ = 2 rt. ∠s (Prop. 1).
γ + θ = 2 rt. ∠s (Prop. 1).
∴ γ + θ = β + δ.
but β = γ (Prop. 6).
∴ δ = θ.

Proposition 7.—Theorem (Converse of Prop. 6)

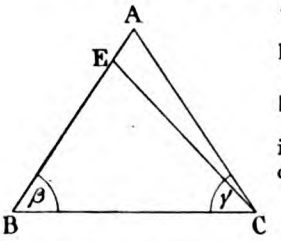
If two angles of a triangle be equal, then the triangle is isosceles.

Let A B C be a △ in which β = γ (Fig. 2).

It is required to prove that A B = A C.

Proof.—Suppose the △ A B C folded so that C falls on B; if D be the pt. on B C where the crease comes, then C D, one of the arms of γ, coincides with B D, one of the arms of β.

∵ β = γ ∴ C A (the other arm of γ) falls on B A (the other arm of β).
∴ △ A D C fits exactly on to △ A B C.
∴ A B = A C.



Alternative Proof.

Let A B C be a △ having ∠s β = γ.

It is required to prove that A B = A C.

If A B does not = A C it must either be greater or less than A C.

Suppose A B > A C.

From B A cut off B E = A C. Join E C.

In △s E B C, A C B
E B = A C (construction).
B C = C B (identical) included ∠ β = ∠ γ
∴ △ E B C ≡ △ A C B (Prop. 5).
i.e. the △s are equal in area.
i.e. the part is equal to the whole, which is impossible.
∴ A B is not > A C.
Similarly it may be proved that A B is not < A C.
∴ A B = A C.

(**Note.**—This indirect method of proof is called *reductio ad absurdum.*)

Exercise 3

1. If two straight lines intersect at a point, and one of the angles formed is a right angle, prove that the other three angles are also right angles.

2. If the angles at the base of a triangle are equal and the base is produced both ways, the exterior angles thus formed are equal.

3. If A B C is any angle, and C B is produced to any point D, the bisectors of the angles A B C and A B D are at right angles.

4. Two straight lines A B, C D bisect one another at E. Prove that if A C and B D be joined the triangles A E C, B E D are equal in all respects.

5. If on the base A B and on opposite sides of it two isosceles triangles A C B, A D B be drawn, prove that the straight line C D joining their vertices is at right angles to the base A B.

6. The side A C of a triangle A B C is bisected at D. B D is joined and produced to E so that D E = D B and E C is joined. Prove that triangles A B D, C E D are equal in all respects. Hence deduce that the exterior angle of a triangle A B C formed by producing B C, is greater than the interior and opposite angle at A.

7. Draw a straight line A B 5 cm. long and make the angles A B C, B A C each equal to 45°. What do you find about the length of the sides C A, C B? And how many degrees is the angle A C B?

8. On a straight line A B 5 cm. long describe an isosceles triangle A B C having C A = C B = 6 cm. Measure by means of the protractor the angles C A B, C B A. They should be equal. Why?

9. In a triangle A B C, the middle points of A B and A C are D and E. From D a perpendicular is drawn to A B and from E a perpendicular is drawn to A C. These perpendiculars meet at O. Prove that the point O is equidistant from the points A, B, C.

The student in drawing figures should never make any lines or angles equal, unless they are specified as equal, and never make any angles right angles, unless they are so specified. M. A. L.

Continued from page 126.

BUSINESS AND COMMERCE

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall)

COMMERCIAL TRAINING.—III

It is only in the normal nature of things that offices vary a great deal in routine, according to the type of profession or business carried on. Thus, in one office the newest junior, whether girl or boy, will press-copy the letters, dispatch them, keep the stamps, and even address the envelopes. In other offices there may be a separate assistant for each of these tasks.

Generally speaking, however, the correspondence clerks address the envelopes, and as in most cases this address also appears on the letter itself, it becomes almost automatic that the dispatch clerk should scan both letter and envelope, trying always to observe any discrepancy. And should there be a mistake, he should raise a query with the correspondence clerk; or, alternatively, make a search in the office address book or the file in which incoming letters are put away.

The Stamp Book

Almost invariably the dispatch clerk will have the keeping of the stamps and stamp book, and each item, if it only be one halfpenny, must be entered. Stamp books are not kept solely as a check on the honesty of the clerk, but have far wider uses. In the first place, in all businesses even pennies must be accounted for if the system and organisation of the establishment is to be carried out to the letter, but apart from this it is often necessary to look back and ascertain if an invoice was sent to so-and-so on a certain day under cover of a halfpenny stamp and whether a small parcel, costing probably 6d., was dispatched to a particular firm at the beginning of the month.

The general system is for stamp accounts to be kept in a kind of day book—that is, a book ruled on both sides for cash and giving also a margin for the date. The dispatch clerk receives from the cashier or clerk in charge of the petty cash an amount, say £2, for the purchase of stamps. This he enters on the left-hand side of his book:

Oct. 10	*To Cash*	£2	0	0

Then he goes to the post office and purchases such stamps as he knows by experience he will most require and probably he will buy three-halfpenny stamps to the value of 25s.; halfpenny ones totalling 5s.; eight at 2½d. for foreign postage, 1s. 8d.; 46 at 1d., 3s. 10d.; and six ninepenny ones for telegrams, 4s. 6d.

Striking a Balance

The outgoing amounts he will enter on the right-hand side of his book, thus:

		£	s.	d.
Oct. 10	*Shawyer* . .			1½
,,	*Wilson* . .			½
,,	*Dawson* (*Russia*)			2½
,,	*Hilditch* (*Telegram*)			9½
,,	*Harris* . .			1½
,,	*James* (*Parcel, Registered*) .			8

and so on. At the foot of the page he will total the amount on the left-hand side and enter it on the last line: Carried forward: £2 : 0 : 0; the same on the right with the corresponding amount. On the new page the first entry will read

Brought forward . £2 : 0 : 0

on the left, and the corresponding figure on the right.

At regular intervals, usually weekly, a balance will be struck and the amounts checked, a proceeding which takes the following course: First the clerk adds up the total of the left-hand side, then the total on the right. He subtracts the latter from the former and the balance ought precisely to represent the stock of stamps he holds.

When he has balanced satisfactorily he finishes the account in this manner: On the

left-hand side he rules two lines and between them inserts the exact total, thus :

£2 : 0 : 0

On the right he inserts the item :

		£	s.	d.
Balance to date	. .		6	7

and below that draws the two lines and inserts the total, which, of course, should also be

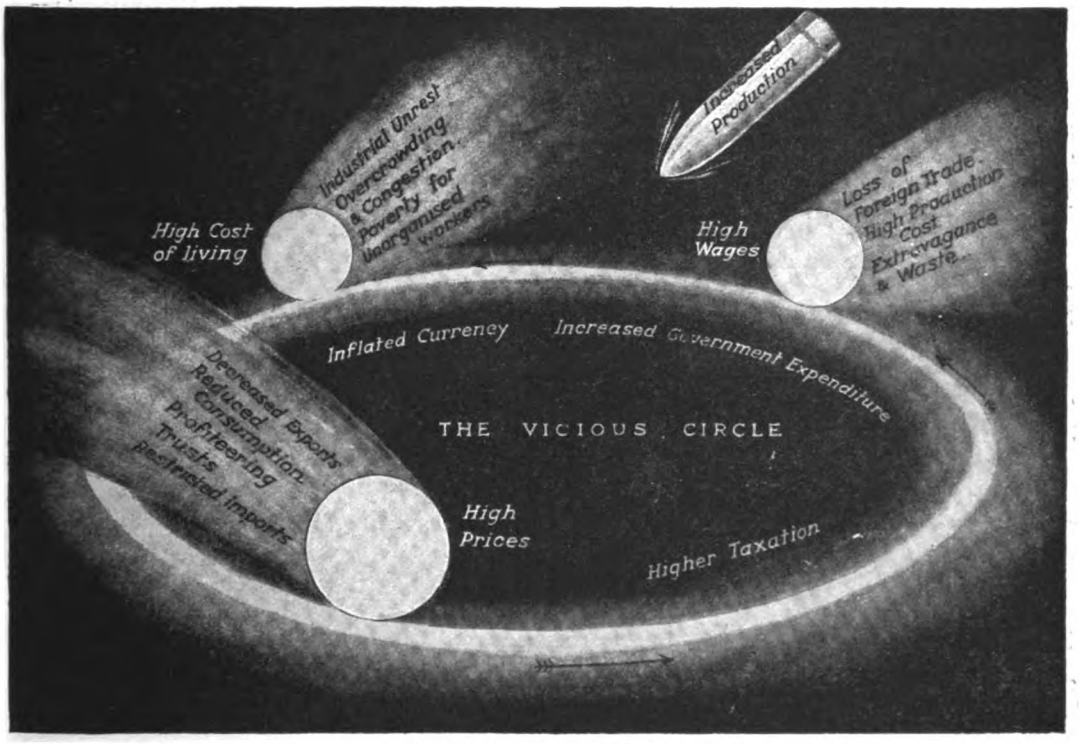
£2 : 0 : 0

His new account he then begins on the left-hand side with the item :

			£	s.	d.
Oct. 17	*By Stock*	. .		6	7

With some firms the actual time of posting a letter or dispatching a telegram is entered in the post book, but this is by no means a common rule.

Printed forms play a part in the majority of offices. There are ordinary memorandum forms on which notes may pass from one department to another ; official petty cash vouchers on which particulars are furnished of the expenditure of small amounts ; requisition forms for stationery or appliances ; receipt forms ; invoice forms ; forms for estimates ; quotation forms ; wages forms for the works department ; transfer forms for stock or shares ; reports forms for the travellers and so on. Care must be taken by the clerk in charge that the day never comes when one of them is out of stock.



SOLVING THE PROBLEM.

The mad whirl of high prices, high wages, and high cost of living round and round the vicious circle is shown above. One thing alone can break the circle—the shell : "Increased Production."

Counting-house routine is, of course, totally different from that of the correspondence department. In the counting-house there are ledger keepers, who attend to the individual accounts of customers and clients ; cashiers, who attend to the incoming and outgoing of money ; accountants, who overlook the book-keeping of the others and prepare the general accounts of the house ; wages clerks and all who have the keeping of books, a science that is explained in detail under the heading Book-keeping.

The secretary has under him the correspondence department, with clerks for keeping the minutes of meetings, shorthand clerks, typists, probably a registrar for dealing with the transfer of the company's stock or shares, and the actual correspondence

clerks. The cashier has a separate department, though it will probably be quartered in the counting-house, which includes collectors and pay clerks, and there is usually an auditor on the permanent staff who works in conjunction with an auditor engaged periodically from an outside firm of auditors and chartered accountants.

The junior, therefore, who begins in almost any of these departments must regard his first post purely as a jumping-off ground to something higher; and whilst he is copying his letters, keeping his post book, or performing any other of the minor routine duties, he must be casting his eyes about him and making up his mind to which of the main departments he will eventually endeavour to transfer his efforts, or whether he will remain in the department where he is making his services acceptable at the moment.

Let him not only be thinking and planning as to what his next step shall be, but let him also be devoting a part of his leisure at least to active and practical preparation for the desired promotion. A. B.

CHOOSING A CAREER.—III

Agriculture (*continued from p.* 124).—An adequate return on capital and labour—this is what the young farmer must aim at.

FRUIT FARMING offers such a return. British home-grown fruit is actually producing higher prices than ever, despite the huge quantities of fruit that are imported from other countries and from our overseas Dominions.

In the Vale of Evesham, in Kent, in Herefordshire, and many other parts, there are entire sections of the country-side devoted to the cultivation of fruit, whilst on the slopes of the Mendips in Somerset, and in Hampshire as well, there are wide-spreading tracts given up to the raising of strawberries.

Growers who go systematically into their calling, grading the fruit, packing with care and efficiency, marketing intelligently, and keeping well abreast of the times undoubtedly prosper, and it has been said that "mixed" plantations, i.e. those planted with standard trees and having under them bush fruit (currants and gooseberries), will yield in the best seasons from £50 to £60 per acre. Even the bad seasons are by no means unprofitable in these days of checking the vagaries of frost with mechanical smother fires, of spraying to destroy pests, and of the wide uses of chemical fertilisers.

To become a fruit grower the same hints apply as those given for other branches of agriculture. First obtain experience, then gather together ample capital, not only to start with, but also to carry on during the first season, and, last, but not least, do not begin in too ambitious a way.

GROWING FLOWERS FOR MARKET is yet another branch of the cult of the smallholding, one particularly adapted to the care of women workers. In this case, the actual marketing is usually done through a commission agent, and great care must be exercised in the selection of such an agent.

Almost every kind of flower, bulbous, perennial, or annual, is saleable, but the best price is obtained for those that last long in water, such as marguerites, stocks, chrysanthemums, China asters, and so on. Flowers that drop their petals readily are not so saleable, and all flowers for market must be picked just before the blooms unfold.

MARKET GARDENING as a calling presents good openings to the smart young business man, willing to work his way through a course of instruction in the practical side of the trade. Rather less capital is required than for dairy farming, for instance, but attached to such a business there must be a really smart salesman, who can not only dispose of actual wares, but also anticipate a demand and see that supplies are ready to meet it.

The principal points about starting a market garden are to find a suitable site at a reasonable rent within measurable distance of a good market, and then to go in for produce of the first quality, always early. Naturally, a garden upon a gentle slope to the south is the one to be sought and the land must be rich and in good heart, or it will run away with too great a proportion of the returns for the supply of manure.

NURSERY GARDENING is naturally upon quite a different footing. Here one may have to wait years for one's stock to mature sufficiently for it to be placed upon the market, and even then one has to create a demand by the gentle arts of advertising.

Often it is advisable for the beginner to purchase an established nursery business. These are frequently offered in the columns of the trade newspapers.

To conduct a nursery garden, and render it financially a success, one must possess a good knowledge of grafting and budding and of every form of propagation. Further, the greatest care must be taken to send out only sound stocks.

Many nursery gardeners specialise, some in roses, others in fruit trees, others in

perennial plants, others in shrubs, and so on; but a big representative nursery catering for every demand requires a great many years of patient endeavour to build up, though it is undoubtedly profitable under satisfactory management.

JOBBING GARDENING. Regarding this work—that is, of taking charge of people's gardens under contract by the year or quarter or by the day—much might be written. Undoubtedly there is quite a big field here for enterprise, especially if the jobbing gardener can conduct as an attribute to his business a small nursery garden for the supply of bedding plants to his customers. Carefully built up and ably supervised, there is no reason against a very useful connection being established. Several women have made themselves sufficiently adaptable to set up in this line in suburban districts.

LANDSCAPE GARDENING, naturally, is on a higher plane. In its efficient execution space is required and the landscape gardener should have travelled, gaining a knowledge not only of British gardens, but also of those in other lands. Many ladies have become highly-successful landscape gardeners, and in the pursuit of their craft most of them have found the ability to paint in water colours of the utmost value. Roughly speaking, this type of work consists of taking a bare and uncultivated piece of ground and planning upon it a garden that shall be individualistic and also carry out the often ill-expressed wishes of the owner or occupier.

Gardeners on a big estate usually begin their business life as garden boys, living in a bothy with the men, assisting at odd jobs and gradually learning their trade and working their way up to positions as qualified journeymen. Those who would excel at their work in this direction should not be content merely with the knowledge gained in the course of their day's toil, but should, where possible, attend technical classes in the evening for the study of botany, hybridisation, character of soils, fertilisers, &c.

There is an examination conducted by the *Royal Horticultural Society, Vincent Square, Westminster, London, S.W.*, for working gardeners. Those who study the course and pass the test receive a diploma that carries much weight with employers. Even gardeners, like farmers, should not be content with the methods of their own particular neighbourhood, and the young worker who can gain experience in different parts, if possible as far apart as Scotland and Cornwall, will undoubtedly benefit himself.

In all these callings, the offsets, as it were, of the parent, Agriculture, there are countless openings for women workers. A. C. M.

Photo: Illustrations Bureau.

PEACHES FOR COVENT GARDEN.

Fruit growing in districts such as the Vale of Evesham is a very delightful and may be a very profitable occupation. But seriously to undertake the cultivation of fruit one must possess capital.

BOOK-KEEPING AND ACCOUNTS.—III

CLEARLY, there will come a time when the accounts must be "closed," "ruled off," or "balanced." This is generally done once a year, if not more frequently. The example shown on the opposite page, of the Ledger in the last lesson (p. 126), illustrates how accounts are closed, so that the difference between the Debit and Credit sides and the final position of an account can be seen at a glance.

It will be seen that an account is "balanced" by placing on the side where the amount is smallest the difference between the total of Debits or Credits, as the case may be. A single line is then ruled, and the total amount entered, the two sides now being equal. A double line is ruled under the total on each side, and the amount of difference, or balance, is carried down on the side which was heavier.

In the Capital Account, as there is only one item on the Credit side, it will remain exactly as shown.

In the Cash Account the total on the Debit side is £520, whilst the Credits amount to £110. The difference, £410, is therefore placed on the Credit side, preceded by the words "By balance," and in the folio column "c/d." (carried down). The totals are filled in and ruled off, and the amount of difference (£410) carried down on the Debit side.

In the Purchases Account there are two items, which together amount to £187 10s. As there are no entries on the Credit side, all that need be done is to rule a single line under the second entry and put in the total.

In the Sales Account there is only a single item on the Credit side, and this is treated in the same way as the Capital Account.

In the account of W. Lees, the difference between the Debit and Credit sides is £50. This amount is added on the Debit side, the account ruled off, and the balance brought down as a Credit balance, showing that the trader still owes this amount.

A. Shaw's account is treated in the same way as the Capital and Sales Accounts, there being only one item on the Credit side.

F. Smith's account shows a difference of £5, and this amount is added on the Credit side and carried down as a Debit balance after the totals have been ruled off.

The Wages Account, having only one entry, is treated in the same manner as the Capital Account.

Before dealing with the Ledger more fully, it may be well to explain the form of Book-keeping used in actual business.

It would be possible for a business man to have these records kept by means of the Journal and Ledger only, or even by means of the Journal only, but in order to meet the needs of modern commerce, with its multiplicity of similar transactions, the two books named would be inadequate, and some better system of grouping must necessarily be adopted.

The first of the so-called "Subsidiary" books, or books of original entry, to which the student's attention is directed, is the

Purchases Book.

When goods are purchased, the buyer usually receives an invoice.

If, for example, A. Venture buys goods from James Green, a dealer in furniture, the invoice would be made out as shown on p. 190.

It is the information contained in the invoice which is entered in the Purchases

PURCHASES BOOK

19..				*Rate*	*Fol.*	£	*s.*	*d.*	£	*s.*	*d.*
Feb.	1		JAMES GREEN								
		30	yds. worsted per yd.	7/6		11	5	–			
		84	„ satin „ „	10/6		44	2	–	55	7	–
„	6		THOMAS BLACK								
		90	yds. cotton	1/1		4	17	6			
		600	„ zanella	1/2		35	–	–	39	17	6
„	9		ARNOLD WHITE								
		10	yds. tapestry	3/–					1	10	–
„	10		BROWN BROTHERS								
		90	yds. worsted	7/6		33	15	–			
		100	„ cotton	1/1		5	8	4			
		4	„ satin	10/6		2	2	–	41	5	4
									£137	19	10

CAPITAL ACCOUNT (1)

						19.. Jan. 1	By Cash		£ 500	s. –	d. –

CASH ACCOUNT (2)

19..			£	s.	d.	19..			£	s.	d.
Jan. 1	To Capital		500	–	–	Jan. 7	By W. Lees		100	–	–
„ 15	„ F. Smith		20	–	–	„ 21	„ Wages		10	–	–
						„ 31	„ Balance	c/d	410	–	–
			£520	–	–				£520	–	–
Jan 31	To Balance	b/d	410	–	–						

PURCHASES ACCOUNT (3)

19..			£	s.	d.
Jan. 2	To W. Lees		150	–	–
„ 9	„ A. Shaw		37	10	–
			187	10	–

SALES ACCOUNT (4)

						19..			£	s.	d.
						Jan. 3	By F. Smith		25	–	–

W. LEES (5)

19..			£	s.	d.	19..			£	s.	d.
Jan. 7	To Cash		100	–	–	Jan. 2	By Purchases		150	–	–
„ 31	„ Balance	c/d	50	–	–						
			£150	–	–				£150	–	–
						Jan. 31	By Balance	b/d	50	–	–

A. SHAW (6)

						19..			£	s.	d.
						Jan. 9	By Purchases		37	10	–

F. SMITH (7)

19..			£	s.	d.	19..			£	s.	d.
Jan. 3	To Sales		25	–	–	Jan 15	By Cash		20	–	–
						„ 31	„ Balance	c/d	5	–	–
			£25	–	–				£25	–	–
Jan. 31	To Balance	b/d	5	–	–						

WAGES ACCOUNT (8)

19..			£	s.	d.
Jan. 21	To Cash		10	–	–

Book. In some cases all the details are entered, whilst in others only the total.

JOAN LANE,
BIRMINGHAM.

MR. A. VENTURE, *25th February*, 19..
LEADENHALL STREET,
LEAMINGTON.

Bought of JAMES GREEN.

Terms of payment, 2½ per cent. one month.

				£	s.	d.
1	Fumed oak roll-top desk			5	–	–
2	Vertical filing cabinets		1/9/-	2	18	–
3	Revolving chairs ..		23/-	3	9	–
1	Typewriting table..			1	17	6
				£13	4	6
	Per L. and N.W.R. Carriage paid.					

whereby the invoices can be readily referred to. They are usually filed numerically, but in certain cases it is found advantageous to have them filed alphabetically. Where purchases are shown in detail in any exercise which may be worked, the student is advised to adopt the detailed Purchases Book.

As the Purchases Book is a record of things coming in, the total of the Purchases Book should be posted as a Debit in the Purchases Account in the Ledger, whilst the account of the person sending or giving each particular lot of goods must be credited. The only entry necessary in the Purchases Account in the Ledger is the total, as shown below.

It will be noted that if these records had been made in the Journal it would have been necessary to have posted each item separately to the Purchases Account in the Ledger.

Dr. PURCHASES ACCOUNT *Cr.*

19..				£	s.	d.
Feb.	28	To Sundries as per Purchases Book		137	19	10

Some firms continue to make use of the old-fashioned "Invoice Guard Book," in which the actual invoices are pasted after being carefully folded. The invoices are fixed on the left of the page, the name of the firm being written on the outer fold. The total is written in a specially ruled cash column on the right of the page, the totals being carried forward from page to page until the end of the month, or whatever other period is found suitable. The Invoice Guard Book is a cumbersome method of dealing with invoices, but it is mentioned here in order that the student may be aware of its existence.

A much better method is for the particulars to be entered in a Purchases Book as on p. 188.

A Purchases Book kept in this manner is complete in itself, and obviates the necessity of having to refer to the actual invoices. In many cases, however, details are omitted in the Purchases Book, and a record made only of the date, the name of the seller and the total amount of the invoice. When this system is used, some method has to be devised

The accounts of Green, Black, White, and Brown will be credited as shown in Green's account below.

The total of the various credits made to the personal accounts of the sellers will balance the total Debit of Purchases Account, and in this way the principle of double entry is strictly adhered to.

Dr. JAMES GREEN *Cr.*

19..				£	s.	d.
Feb.	1	By Purchases		55	7	–

Commercial Terms.

Discount in the ordinary sense is an allowance for prompt payment, and takes the form of a deduction from the amount actually due.

Methods of Payment. Amounts due may be discharged by means of—

(1) Cash.
(2) Postal Orders.
(3) Money Orders.
(4) Bank Notes.
(5) Cheques.
(6) Bills of Exchange.

Each of these methods of payment will be explained in due course. F. H.

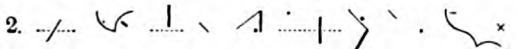
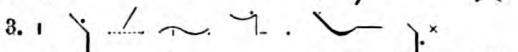
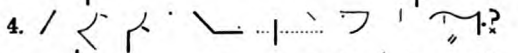
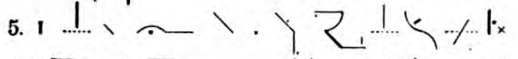
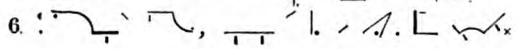
SHORTHAND.—III

(Continued from p. 128)

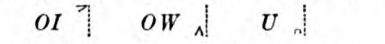
Key to Exercise 13.

1. *The happy* fellow *put up at the* inn *on the* road *to* Dundee.
2. Tom *and* Harry hope *to be out by* four.
3. *He should be* ready *to* take *it by* Monday.
4. Laura *should be happy to buy a* copy *of the* book.
5. Take *the* coffee, *the* tea, *and the* cocoa *to* 18 Ferry Road *on* Monday.

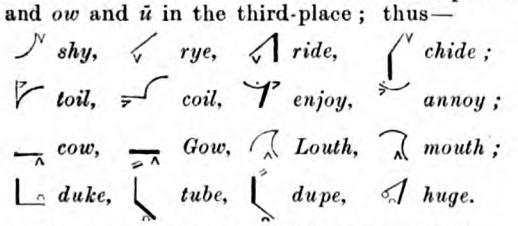
Key to Exercise 14.

1.
2. 
3. 
4. 
5. 
6. 

Diphthongs.—A brief glance at the words *tie, coy, cow, cue,* will convince the student that here there are sounds not yet provided for. These sounds are the four common diphthongs, *I, OI, OW, U,* which are represented as follows—

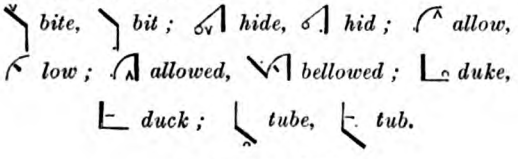


Note that *ī* and *oi* are written in the first-place, and *ow* and *ū* in the third-place; thus—



shy, rye, ride, chide; toil, coil, enjoy, annoy; cow, Gow, Louth, mouth; duke, tube, dupe, huge.

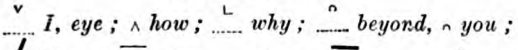
The student should carefully note the difference between vowel-sounds and diphthong-sounds, although the spelling of the word may be similar, as in—



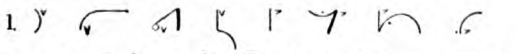
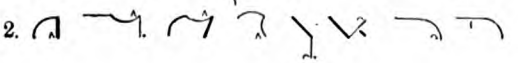
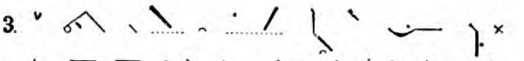
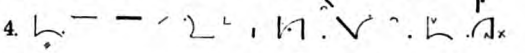
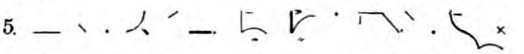
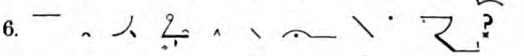
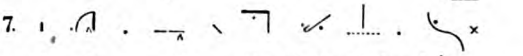
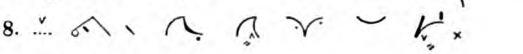
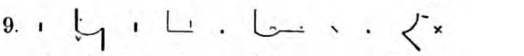
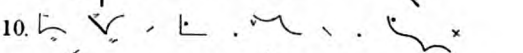
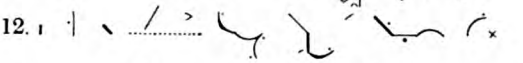
bite, bit; hide, hid; allow, low; allowed, bellowed; duke, duck; tube, tub.

Exercise 15.

GRAMMALOGUES.



I, eye; how; why; beyond, you; large; can, come; go, give-n.

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
11.
12. 

Key to Exercise 15.

1. sigh, like, hide, tire, toy, enjoy, toiler, alloy.
2. loud, county, lounge, mouth, beauty, bureau, cure, cur.
3. *I* hope *to buy you a large* tube *of* ink *to*-day.
4. Tim *can go and* ask *why he* delayed *the* bill *beyond the* time allowed.
5. *Come to the* show *and give* Tom Doyle *a* copy *of the* form.
6. *Can you* show Hugo *how to* make up *a* cash-book ?
7. *He* allowed *the* cow *to* get away *at the* fair.
8. *I* hope *to* leave Louth early *in* July.
9. *He* denied *he* took *the* tunic *to the* shop.
10. Tom Boyle *should* take *the* knife *to the* farm.
11. Harry *and* Tom live *at* 28 Bute Road, Filey.
12. *He* ate *too much of the* vanilla pudding *and* became ill.

Joined Diphthongs.—Where convenient the diphthong-signs may be joined; thus—

item, ivory, ire, nigh; oil; owl, bow, vow; sue, view, Matthew, due.

Note how the signs are joined in the following outlines—

new, cue, value, now, isle, awl.

Triphones.—Any short vowel which immediately follows a diphthong, may be expressed by a short tick written upward or downward; thus—

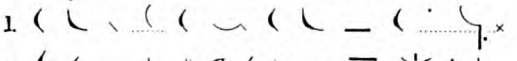
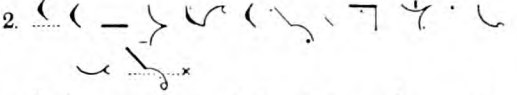
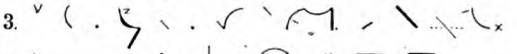
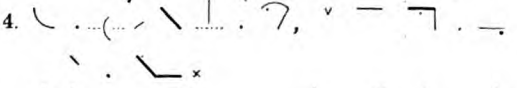
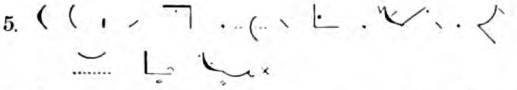
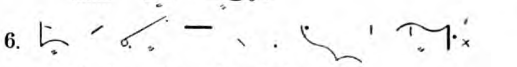
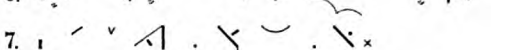
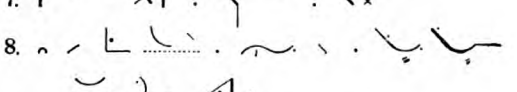
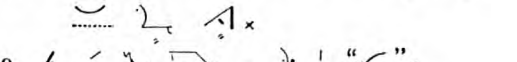
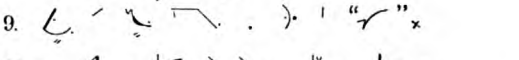
dial, voyage, towel, genuine.

These signs are called *triphones*, and they are written in the places of their diphthongs.

Exercise 16.

GRAMMALOGUES.

half, *if*; *have*; *thank-ed*, *think*, *youth*; *though*, *they*, *them*.

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10. 
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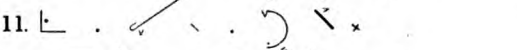
12. 

Key to Exercise 16.

1. *They have to thank them* now *they have given them a half*-day.
2. *Though they give* full value, *they* appear *to* get only *a* few new *buy*ers.
3. *I think the* voyage *to the* Isle *of* Lundy *should be put* off.
4. *If the youth should be at the* match, *I can* get *the* key *of the* bag.
5. *They think he should* get *the youth to* take *the* ivory *to the* shop *in* Duke Avenue.
6. Tom *and* Harry *go to the* farm *on* Monday.
7. *He and I* rowed *the* boat *in the* bay.
8. *You should* take *half of the* money *to the* Penny Bank *in* Askew Road.
9. Jenny *and* Ivy copy *the* essay *on* "Oil."
10. *He* read *the* tale *of* poor Tiny Tim.
11. Take *the* wire *to the* Irish boy.
12. *He can buy the* perfume *at the* shop.

The outlines for the words *full* and *only* in Exercise 18 show the stroke *l* written downward; hence it follows that *l* may be written either upward or downward. In words like *full*, *vale*, where the *l* follows *f*, *v*, the *l* is written downward if no vowel follows, and upward if a vowel follows; thus—

full, *fully*; *vale*, *valley*.

After *n* and *ng*, final *l* is always written downward, in order to have an easy joining; thus—

only, *mainly*, *wrongly*, *kingly*.

Phraseography.—As the diphthong-signs are joined to facilitate the writing of the outline, so the outlines for words are joined together. This is called *phraseography*, and the resulting outlines are called *phraseograms*; thus—

I have, *how can*, *why do you*.

Where the sign for *ī* does not join conveniently, the left half of the sign only is used; thus—

I can, *I will*, *I am*.

Tick THE.—The frequently-occurring word *the* is represented by a tick written upward or downward, as here shown—

by the, *of the*, *at the*, *which the*.

Note the slope of *on the*.

Exercise 17.

GRAMMALOGUES.

with, *when*; *what*, *would*; *saw*, *so*, *us*, *sea*, *see*.

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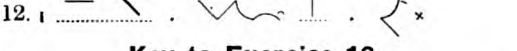
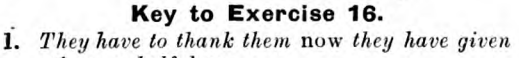
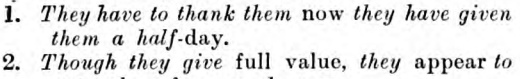
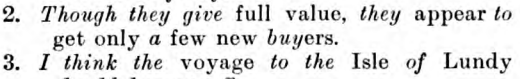
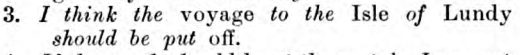
2.
3.
4. 
5. 
6. 
7. 
8. 

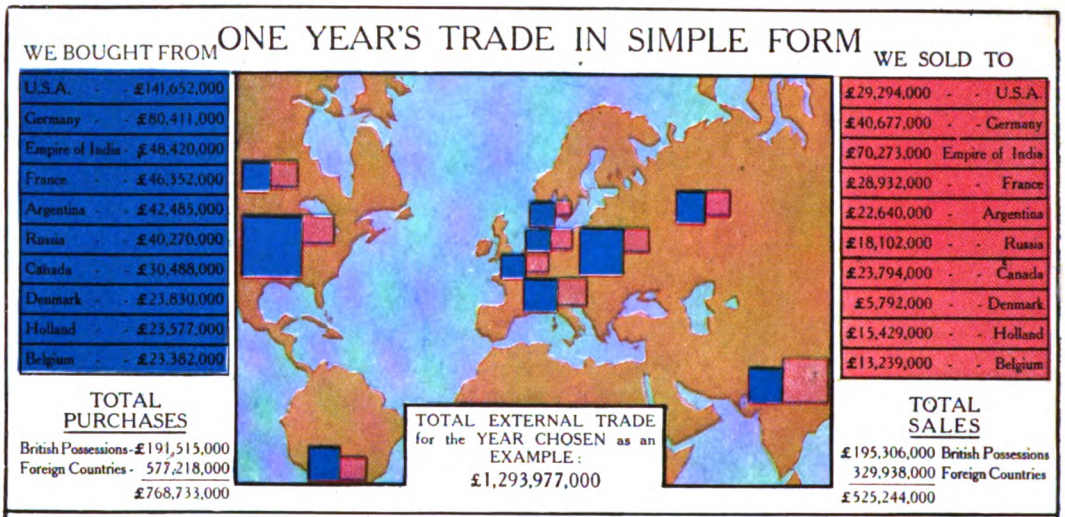
Exercise 18.

GRAMMALOGUES.

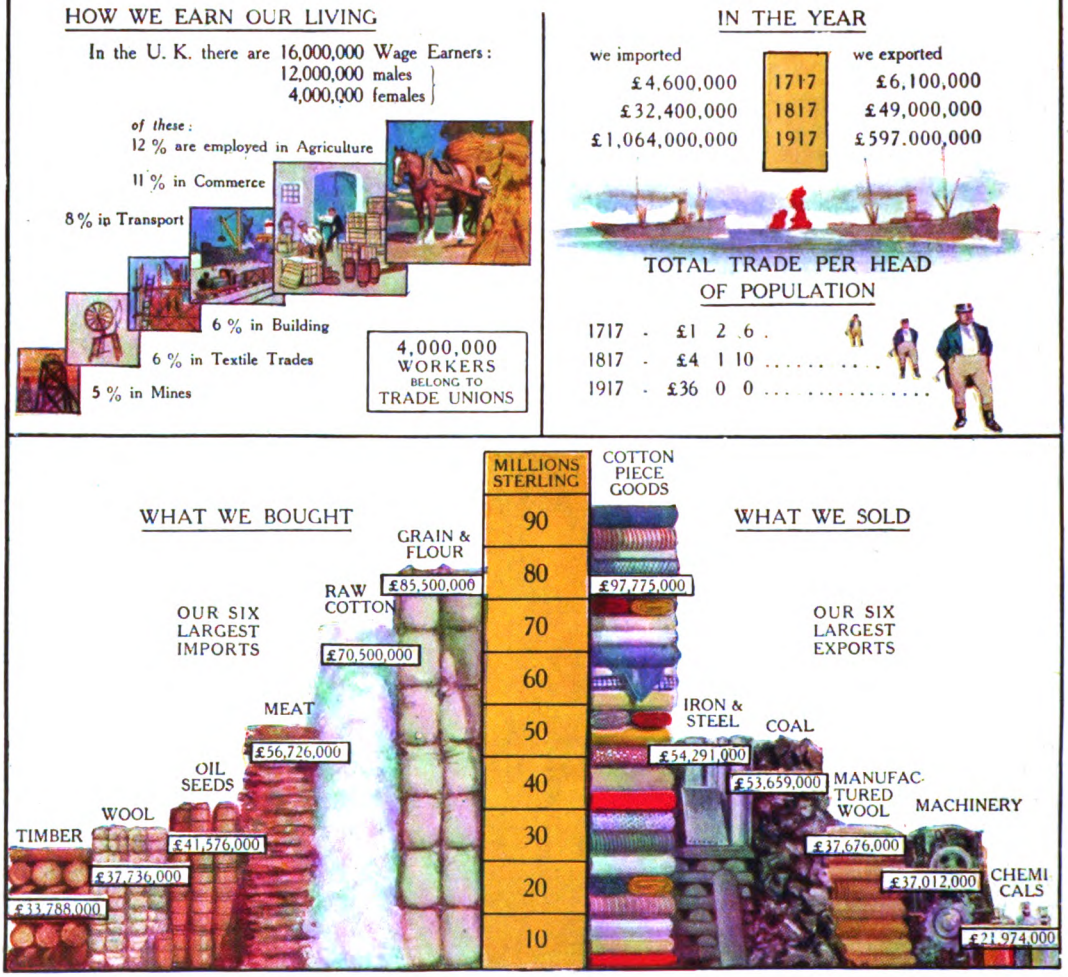
was, *whose*; *shall*, *wish*; *usual*.

[Phraseograms are indicated by the *hyphen*.]

1. *They*-will-*be* ready *on-the*-fourth *if-you wish to see them*.
2. *I-shall* make-*the usual* charge *to-the* county authority.
3. *He-was with-them on-the* quay *when-the* boat *put* off.
4. Dinah Power, *whose* wire *they-had at two*, *should* arrive *at* eight.
5. *If-you*-will ship *the* oil *to*-morrow, *I*-will mail *you a* cheque *on-the*-tenth.
6. *I-have to* ask-*you to*-write *to-the* firm *on-the*-fifth *of*-July.



THE COMMERCE of the U. K. explained by DIAGRAM



FROM WAR TO PEACE.

This chart shows more clearly than could any article what Britain must do in order to retain or to regain her commercial supremacy. The figures may be taken as indicating one year's healthy trade, but their value must be regarded as comparative rather than actual, so greatly has the purchasing power of the sovereign fallen owing to conditions arising out of the Great War.

Continued from page 134.

ENGLISH LANGUAGE AND LITERATURE:

Contributors *:*—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

FROM GEOFFREY CHAUCER TO EDMUND SPENSER

If we wish to see the course of English literature through the centuries as in a picture, it may perhaps be best compared to a long journey amid varied scenery—over glorious heights with views of spacious reach, followed, it may be, by breezy plateaus, and, by and by, sinking into the sweet forest glades of lower levels. Then, at times, the path wanders dully across stony, wearisome plains, until it again rises into the upper air, and with exhilaration we survey fresh scenes of beauty.

In the writings of Geoffrey Chaucer, as we have seen, the traveller along the highway of our nation's literature first reaches the invigorating uplands, and mounts one of the peaks that is seen far across the centuries.

Towards Elizabethan Grandeur

It might have been thought that from such a height the descent would have been slow, and the journey not soon devoid of interest. But that is not what happened. At once the way sank to a dreary plain, and many a mile was traversed before any promise of refreshing change again was found.

But at last the path began to rise out of the common lowlands; the scenery became first pleasant, then romantic, and presently, after swift climbing into purer air than had been known before, and on a crowning height, fairyland itself was entered.

That is the literary panorama of two hundred years—from Geoffrey Chaucer to Edmund Spenser.

Chaucer's *Canterbury Tales* were published just about two hundred years before Spenser's *Fairy Queen* was published. Chaucer died just about two hundred years before Spenser died and was laid by his side in the Poets' corner of Westminster Abbey. For at least one hundred and fifty years the way between Chaucer and Spenser was grievously tame and depressing; but it brightened steadily in the fourth fifty years, until Spenser gave it a triumphant entry into the Elizabethan glory-land.

The English Bible

Here we have first to hasten across the grey waste that succeeded Chaucer's cheerful day; then, to glance at a few of the poets who mark the rise towards Elizabethan grandeur; and, finally, to see Spenser as a mountain of enchantment across which the path lies to the great range where Shakespeare tops the literature of the world.

The supreme book of the period was the *English Bible*. The only other book that can be called literature of great distinction, written during the century and half after the death of Chaucer, was also written in prose—Sir Thomas Malory's *Morte d'Arthur*.

Reference will be made to these books presently, when the tributary stream of prose is traced to its source. There were, of course, many writers of verse, but the time did not produce great, nor even readable, poetry, if we omit the old popular ballads, of unknown date, some of which were now being cast into their final form.

The best verse between the time of Chaucer and the second quarter of the sixteenth century came into our language from Scotland. While it will not, as a whole, tempt the general reader, it has a scattering of features of true poetry.

John Barbour, archdeacon of Aberdeen, a contemporary of Chaucer but an older man, may be called the first Scottish poet.

His chief work was *The Bruce*, a rhyming narrative telling, with all the licence of romance, the story of the liberator of Scotland. A note of ardent patriotism gives *The Bruce* a dignity which it would not gain from its versification. The spirit of Scotland rings clear, for example, in this fine outburst.

O Freedom is a noble thing!
Freedom makes man to have liking; [*joy*
Freedom all solace to man gives;
He lives at ease that freely lives.
A noble heart may have no ease,
Nor ellis naught that doth him please, [*naught*
If freedom fails. For free liking *else*
Is yearned for, o'er all other thing.
Nay, he that aye has livéd free
May not know well the propertie,
The anger, nay the wretched doom
That is coupléd to foul thraldom.
But if he had assayéd it, [*tried it*
Then in his heart he should it wit, [*know*
And should think freedom more to prize
Than all the gold in world that is.

James I. of Scotland

James I. of Scotland was a close imitator of the early style of Chaucer in a dream poem commemorating first his own misfortunes and then his love. When he was ten years old James was captured off Flamborough Head by the English, and interned, chiefly in the Tower and Windsor Castle, for nineteen years. During his imprisonment he became acquainted with Chaucer's poems, and about 1423, in imitation, wrote his *King's Quair* (that is, King's quire or book), telling how he fell in love with a lady walking in a garden which his prison overlooked.

The story was true and ended happily, for James married Joan Beaufort, daughter of the Earl of Somerset, the lady who brightened his captivity. Though artificial in form, this pretty poem has a natural feeling and sweetness uncommon when it was written. The use by the king of Chaucer's rhymed seven-line verse has caused that measure to be called "rhyme royal."

A noticeable feature of Scottish writings, during the dearth of literary production in England that accompanied our Wars of the Roses, was an appreciation of outdoor beauty. This can be observed in all the Scottish poets of the time who need be mentioned here—Robert Henryson, Gavin Douglas, and William Dunbar.

Henryson, a close follower of Chaucer, lived from about 1430 to about 1505. The exact dates are uncertain. He was a schoolmaster of Dunfermline, and wrote many kinds of verse with unusual grace. The charming love ballad of *Robin and Makyn* is his; and among his rhymed fables—for he translated Æsop—is the brightest and most humorous version we have of the visit of the country mouse to the town mouse, a subject that attracted many poets.

Here is a picture by Henryson of a wood in June.

Sweet was the smell of flowrés white and red,
The noise of birdés right delicious,
The boughés broad blooméd above my head,
The ground growing with grasses gracious,
Of all pleasaunce that place was plenteous,
With sweet odoúrs and birdés harmonie,
The morning mild—my mirth was more thereby.

It will be noted that Henryson's accents fall in many words like Chaucer's, and that "delicious" is spoken as four syllables, and "gracious" as three.

Gavin Douglas, bishop of Dunkeld, lived from 1474 to 1522. In 1513 he finished the translation of Virgil's *Æneid* into English, and this was the first Latin poem translated into English or any other Teutonic tongue.

To each of the books of the *Æneid* Douglas prefixed an original prologue. Here we give his welcome to the sun in spring.

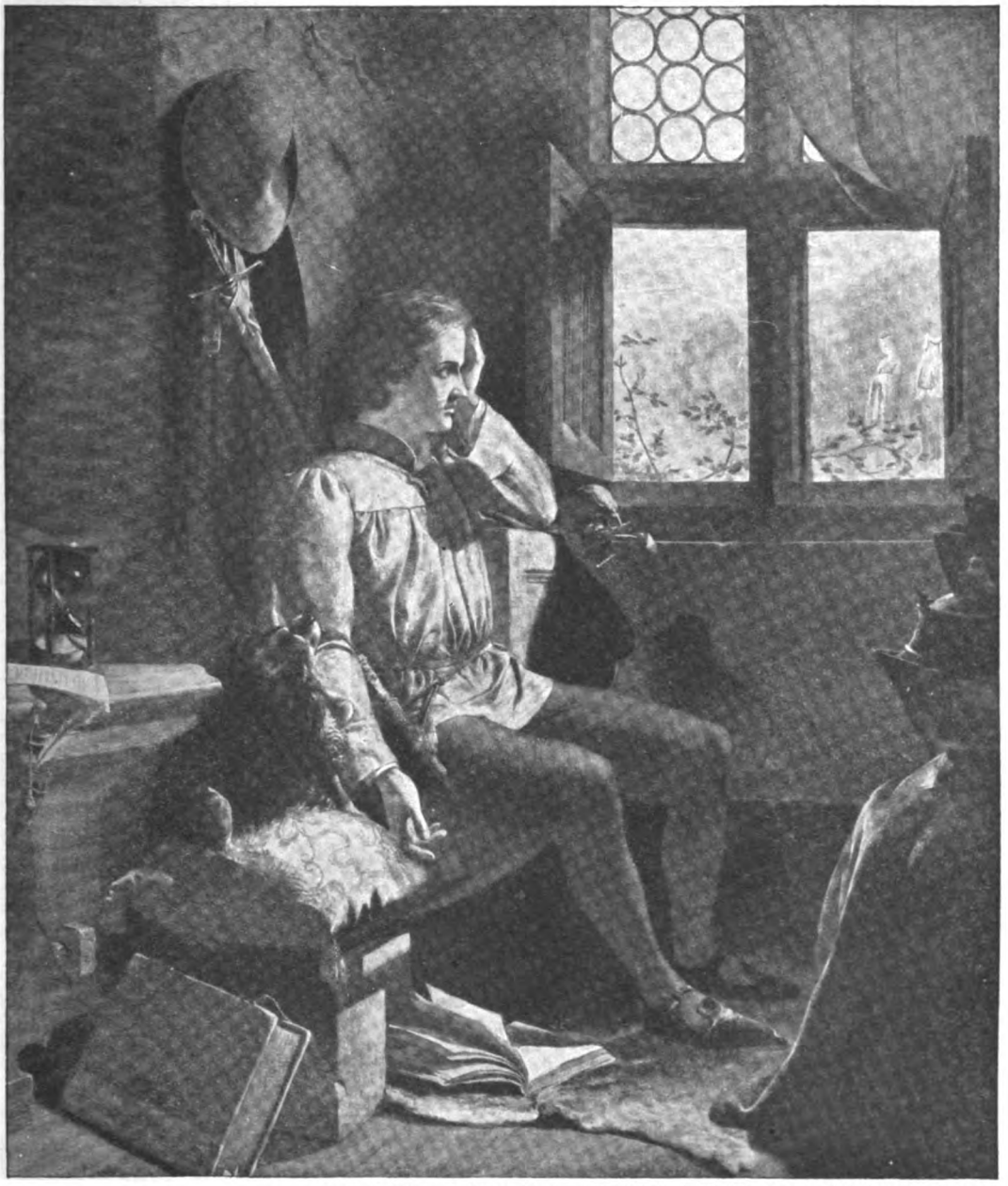
Welcome, the lord of light and lamp of day;
Welcome, fost'rer of tender herbés green;
Welcome, quick'ner of florest flowrés sheen;
Welcome, support of every root and vein;
Welcome, comfórt of all kind fruit and grain;
Welcome, the birdés bield upon the breyr; [*shelter, briar*
Welcome, maister and ruler of the year; [*master*
Welcome, welfare of husbands at the ploughs;
Welcome, repairer of woods, trees, and boughs;
Welcome, depainter of the blooming meads;
Welcome, the life of everything that spreads;
Welcome, storér of all kinds bestial;
Welcome be thy bright beamés gladding all!

Though this Welcome is too much like a catalogue, the spirit of spring throbs in the whole utterance. The old pronunciation of "spreads" as *spreeds* is still common in some parts of England.

The Forerunner of Burns

William Dunbar, the dates of whose birth and death, usually given as 1460 to 1520, are doubtful, has been regarded in his own country as the most considerable poet before Robert Burns.

At first a roving friar, he seems to have finished his life as a pensioned courtier and official rhymester. He visited London with the Scottish embassy which arranged the marriage of James IV. with Margaret Tudor, daughter of Henry VII., and wrote a poem with the refrain, "London, thou art the flower of cities all." When the marriage,



From the picture by James Drummond, R.S.A., in the Royal Scottish Academy, Edinburgh.

KING JAMES I. OF SCOTLAND SEES HIS FUTURE QUEEN.

This royal poet, when a lad ten years of age, was captured by the English off Flamborough Head, and interned for nineteen years, mainly at Windsor Castle where, from his cell window, he saw, in 1423, the beautiful daughter of the Earl of Somerset, Lady Joanna Beaufort, who subsequently became his Queen. His poem, the *King's Quair*, written in a style closely modelled on that of Chaucer, describes the incident.

which eventually brought England and Scotland under one sovereign, took place, Dunbar commemorated it in a poem, *The Thistle and the Rose*, the Thistle, of course, representing James, and the Rose, Margaret.

As a companion to these Scottish poets, no English writers may be named after Chaucer until the second quarter of the sixteenth century, except John Skelton and

JOHN SKELTON (1460-1529).
Reproduced from his *Garlands of Laurel*, 1523.

Stephen Hawes, the latter a groom of the chamber to Henry VII., and writer of a poetical allegory which he named *The Pastime of Pleasure*. Greater poets who followed have admitted the influence of this poem, but today it is only known for the form in which it transmits to us a proverb of those days, a proverb that expresses tenderly the poetry of life's decline—

> But though the day be never so long,
> At last the bell ringeth for evensong.

John Skelton, who was born, probably, in 1460, and died in 1529, was widely known as a scholar, and became the tutor of Henry VIII., when that precocious prince was aged nine. Many of Skelton's early writings have perished, without any loss to the world, for they were principally either formal praise of patrons, or rough satires on other writers. In middle life he took holy orders and became rector of Diss, in Norfolk, to the scandal of the neighbourhood. He now began to satirize bitterly the Court, in his *Bouge* (or Mouth) *of Court*, scorning Court patronage, and the Church in *Colin Clout* (a name afterwards adopted by Spenser).

This latter poem was aimed covertly at Wolsey, who at first had been one of Skelton's patrons. Then, boldly, openly, fiercely, Skelton expressed the popular feeling and attacked the haughty prelate in *Why come ye not to Court?* until at last he had to seek sanctuary at Westminster from Wolsey's anger.

The satirist's style was an invention of his own, a short-lined doggerel easily understood by the people. Skelton's own criticism of it expresses its weakness and its strength.

> For though my rhyme be ragged,
> Tattered and jagged,
> Rudely rain-beaten,
> Rusty and moth-eaten,
> Yet if ye take well therewith
> It hath in it some pith.

In his rough, coarse strength Skelton resembled his Scottish contemporary Dunbar. In little of his work can be found the grace of fine literature; and yet he could sound a gentler strain, as witness his address to Mistress Margaret Hussey.

> Merry Margaret,
> As Midsummer flower,
> Gentle as falcon,
> Or hawk of the tower;
> With solace and gladness,
> Much mirth and no madness,
> All good and no badness,
> So joyously,
> So maidenly,
> So womanly
> Her demeaning
> In everything,
> Far, far passing
> What I can write
> Of merry Margarete,
> As Midsummer flower,
> Gentle as falcon,
> Or hawk of the tower.

If the fifteenth and early part of the sixteenth century only yielded, as we have seen, a kind of poetry, not the best, the sixteenth century, as it advanced farther, became a time of gradual ascent to nobler thought and more musical expression.

With this ascent are associated the names of Sir Thomas Wyatt, the Earl of Surrey, Thomas Sackville (who later became Lord Buckhurst and then Earl of Dorset), and Sir

Philip Sidney ; and it reaches its culmination in Edmund Spenser.

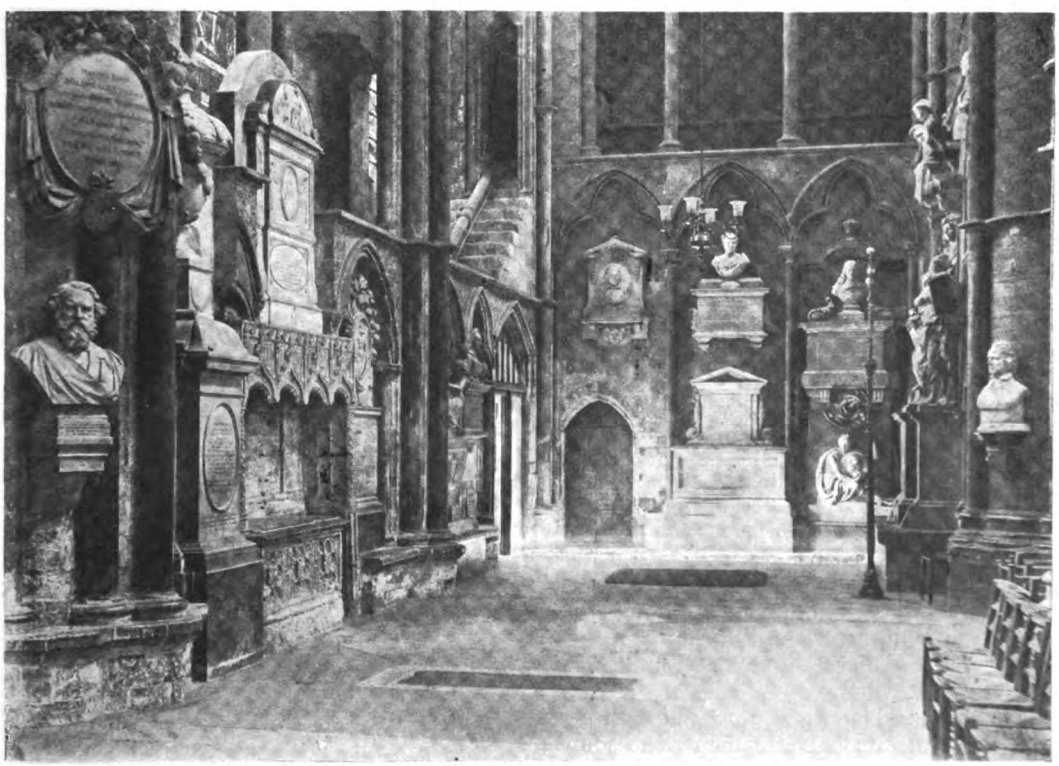
Sir Thomas Wyatt and Henry Howard (by courtesy Earl of Surrey) are usually linked together because their writings were first published together, and they are regarded as jointly giving a start to the great literary movement which reached its high tide in the later years of Elizabeth's reign. Wyatt was the older, more experienced, wiser man. When he died at the age of 39, in 1542, Surrey was only four and twenty.

Wyatt, whose father had been a trustworthy favourite at the Court of Henry VII., served Henry VIII. faithfully at home as a soldier, and abroad as a diplomatist, but was imprisoned several times because of his friendly association with the family of Ann Boleyn, who were neighbours of his in Kent. He died while on an official journey to meet the Spanish ambassador at Plymouth.

Surrey, the eldest son of the third Duke of Norfolk, was a headstrong young soldier, who had fought bravely, if unsuccessfully, in France. He was intensely proud of his family history, which he regarded as placing him in the royal line. This became the means of his undoing, for in the last days of Henry VIII. he was executed on Tower Hill as a possible rival to young Edward VI. Surrey's father, who was also imprisoned in the Tower, escaped a similar fate through the death of Henry VIII.

These courtiers were, by education, products of the Renaissance, for they were familiar with the revived classical learning of Rome and Greece, and its effects on Italian literature, and by imitating in English the forms of Italian and classical verse, they introduced a smoothness and a restraint which had been lacking.

Hitherto English verse had been archaic, even when it was melodious, as in Chaucer ; and generally it was rugged, ungainly, and wanting in artistry. It now began to take new forms, and to sound that lovely personal and lyric note which gives such glamour to Elizabethan verse. Here, for example, is a lilt of love by Wyatt, dainty, haunting, and quite new.



THE POET'S CORNER, WESTMINSTER ABBEY.

The statue on the extreme left of the picture marks Longfellow's grave; the alcove next but one to it is Chaucer's; Edmund Spenser's grave is immediately to the right of the doorway and above it is Samuel Butler's, with Ben Jonson's on its right and Milton's on its left.

And wilt thou leave me thus ?
Say nay ! say nay ! for shame
To save thee from the blame
Of all my grief and grame.
And wilt thou leave me thus ?
Say nay ! say nay !

And wilt thou leave me thus
That hath lov'd thee so long,
In wealth and woe among ?
And is thy heart so strong
As for to leave me thus ?
Say nay ! say nay !

And wilt thou leave me thus,
That hath given thee my heart
Never for to depart,
Neither for pain nor smart ?
And wilt thou leave me thus ?
Say nay ! say nay !

And wilt thou leave me thus,
And have no more pity
Of him that loveth thee ?
Alas ! thy cruelty !
And wilt thou leave me thus ?
Say nay ! say nay !

It was Wyatt who introduced, from the Italian, the sonnet as a poetical fashion—a medium of peculiar value at a time when concentration of thought and attention to form were much needed.

Sonnets and Blank Verse

The strict sonnet, as perfected in Italian by Petrarch, was a poem of fourteen lines, developing a single subject, in a regular sequence of rhymes, only four or sometimes five being used. The poem divided itself broadly into two parts—one of eight lines, and one of six. The eight lines subdivided into two similar fours. The rhymes were in this order : 1, 2, 2, 1 ; 1, 2, 2, 1 ; 3, 4, 3, 4, 3, 4. Or if five rhymes were used the last six would rhyme : 3, 4, 5 ; 3, 4, 5. But these strict forms soon varied, even in Italian, and in English the rhyme arrangement, within the fourteen lines, has been changed into many combinations.

Originally, the sonnet was made almost exclusively the medium of chivalrous and often fantastic love compliments in honour of an imaginary mistress. Usually the fervour was wholly poetic.

But from being a pretty exercise in rhymed and affected sentiment, the sonnet, in English, has been so varied in arrangement and so enriched in its range of subjects by our greatest poets—Spenser, Shakespeare, Milton, Wordsworth, and Tennyson—as to become an almost sacred treasury of choicest poetry, with an outlook as wide as human experience.

Surrey used the sonnet with greater freedom and skill than Wyatt, who had introduced it, and, further, he has the distinction of having first used in English the unrhymed measure known as blank verse—a poetic form through which the rarest genius of our race has since found expression.

Blank verse, borrowed from the Roman poets, was being tried in Italy, and Surrey appropriated it for a translation he was making of the second and fourth books of Virgil's *Æneid*. It has now become, in English, the natural language of great epics and of the heroic drama. Improved in flexibility, dignity, and variety in cadence, by our master poets—particularly by Marlowe, Shakespeare and Milton—it is transformed from the monotony of Surrey's regular lines, but to him belongs the credit of its adoption.

Thomas Sackville

The chief stepping stone between Wyatt in the second quarter of the sixteenth century and Edmund Spenser in the last quarter is Thomas Sackville, who was born in 1536. In early life, while a member of the Bar, he was part author of the first English tragedy, *Gorboduc*, in 1561, and then, in 1563, issued the Introduction to a voluminous publication entitled *A Mirror for Magistrates*.

This latter doleful work was planned to tell, for the reader's benefit, the sad stories of Englishmen of high position who had perished in an untimely manner through ambition ; the stories being furnished by the shades of the departed to the poet, who, led by Sorrow, descends for the interviews into Hades. Only Sackville's share of the *Mirror for Magistrates* has any literary value. His powerful Introduction and his recital of the story of Buckingham (the Buckingham of the reign of Richard III) mark a great advance in the use of the Chaucerian seven-l'ned stanza.

Sackville now ceased writing, entered the Queen's employ, and eventually rose to a high position as Earl of Dorset, and Lord Treasurer in succession to the great Burleigh, an office he retained under James I.

There is no doubt that Spenser was a close student of Sackville's style, for in his prelude to the *Faery Queen* he describes him as one

> " Whose learned Muse hath writ her own record
> In golden verse worthy immortal fame."

J. D.

THE ENGLISH LANGUAGE.—II

A STUDY of Chaucer's language will help us to realise the nature of the movement in the English tongue, one stage of which he has caught and fixed. Amid the wreck of the old grammatical system, we should observe many relics still standing. In the first twenty lines of the Prologue to *The Canterbury Tales* we still find plural adjectives (*sootė, smalė*) ; the weak adjective (the *yongė sonne*) ; verbal forms in **-eth** and **-en** (*priketh, maken*) ; infinitive in **-n** (*gon*) ; old inflections of nouns such as the genitive **-es** and the dative **-e** (from every *schires endė*) ; obsolete forms of pronouns (*his* = its, *hem, here*). The process of simplification was not complete in the year 1400, but there was little further to go.

Changes in grammar were accompanied by changes in syntax and in style, which altered the language still more. A passage of English prose from Alfred the Great reveals a crude and immature instrument of thought. The sentences are short and have a monotonous, staccato ring, the result of their lack of variety and grace. Only the simplest rhetorical effect is obtainable, and neither dignity nor music. There is the minimum of ornament, and no fluency ; the massive rhythm and balance of Latin or Greek prose are impossible ; and no skill in paragraph- or sentence-architecture is shown. There are too many little words, and the language can be used only for the simplest purposes—that is, for direct statements and simple exhortation.

Old English Simplicity

In the poetry the writer's imagination is equally impeded, and only the most obvious and natural metaphors are to be found. Nevertheless, the Old English method of terse and precise statement is still the basis of English composition. We do not favour, even in the twentieth century, the long-drawn-out period, the sprawling array of complex sentences, which has attracted some of our more scholarly writers at different times. The ideal style is that of the Bible of 1611, in the language of which the Old English method, wisely fertilised by other rhythms, reached its zenith.

Changes in our vocabulary is the subject with which we next will deal. Many words have been added to English from outside sources ; but Old English had in itself, like modern German, the power of making new words by composition—a power which is only partially preserved in modern English. We speak of a battle-ship or an air-ship, but also of Dreadnoughts and Zeppelins. Old English made *song-craft* (music), and many similar words ; and this faculty was retained quite late in popular speech, and has been revived in poetry. Hundreds of words remain in the language whose compound nature is obvious ; others, once compound, have lost the evidence of it as they have changed in pronunciation or spelling (*woman, husband, gospel, worship*).

The formation of words by means of prefixes and suffixes is akin to this, the added syllable being originally a separate word ; and of course it is as vital a process as in O.E. For example, we have prudent, *im*prudent, prudence, prud*ential*, prud*entially* ; and there are other cases without end. Yet we do not make to *outgo*, to *throughgo*, but prefer to *go out*, to *go through*, though we have to *undergo*, to *forego*. The use of a preposition as a prefix is thus not general in modern English ; in those words in which it is found, we are dealing with words of older origin ; the prefix has lost its original meaning, and is not separable, as it often is in German. *To undergo* is not the same thing as *to go under*.

New Words

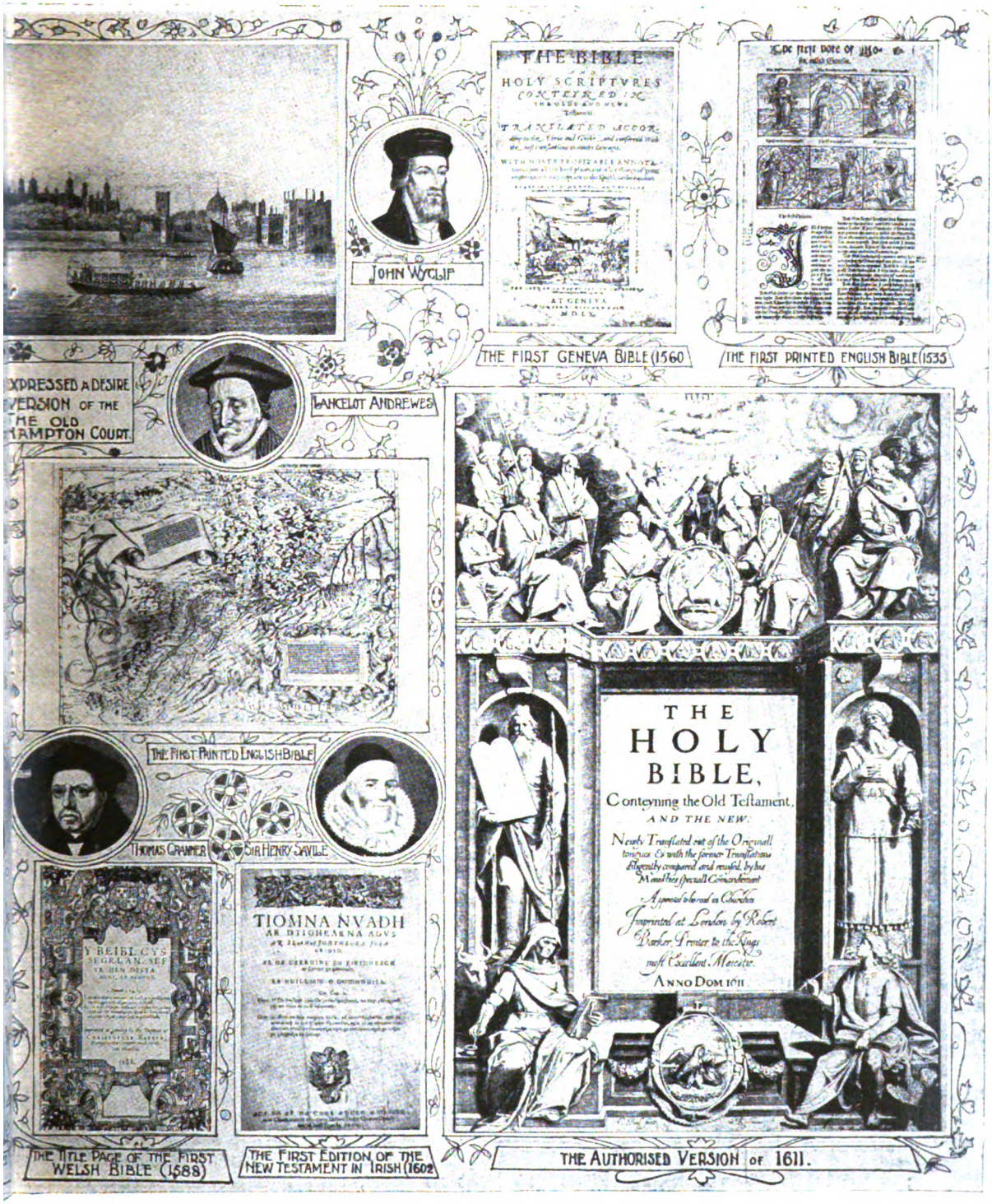
The number of words employed in English and recorded in our dictionaries is continually increasing—(1) by the adaptation of old words to new uses ; (2) by the addition of prefixes and suffixes to words already in use ; (3) by the borrowing of foreign words ; (4) by the coinage of new words from foreign roots for special purposes. The formation of new root-words is now so rare as to be negligible.

The skeleton and articulations of the language are an inheritance from our Old English ancestors. The residue of vital grammatical forms, the pronouns, prepositions and conjunctions, the indispensable names of common objects and simple activities, the auxiliary verbs, are the modified forms of the words our forefathers used.

It is possible to construct sentences which avoid all foreign importations, but impossible to do so without our fundamental English words. Nevertheless, we have to recognise that many Old English words have become obsolete, their place having been taken by more convenient or attractive foreigners. Thus, even in Chaucer we find the verbs *wilne* (desire), *wone* (dwell), and many others ; and to-day *neatsfoot* oil reminds us of the obsolete *neat* (cattle). Poets sometimes employ archaic words

THE ENGLISH BIBLE OF 1611 AND

For that incomparable piece of English Literature, tne 1611 Authorised Version of the English Bible, we are
Court in 1604. Though called the Authorised Version, and though it bears on its title-page the words
been authorised by Parliament, Convocation, or King. Noteworthy among the Bibles shown above are the
Printed English Bible" which, as a



SOME OF ITS PREDECESSORS.

indebted to James I., this Bible owing its origin to the Conference which the King summoned to Hampton "Appointed to be read in Churches," there is—strange to relate—no documentary evidence of its having ever First Great Bible of 1539, which was printed mainly in Paris, the Geneva Bible of 1560 and the "First matter of fact, was produced in Zurich.

(*eke*, *quoth*, *yclept*, *hight*), but their use in prose should not be imitated.

(1) Many instances could be given of the employment of familiar words in new senses. Sometimes this takes place gradually, as in the case of the word *fee*, which is the O.E. *féoh*, cattle, and hence, wealth. In Chaucer the word still retains its meaning of wealth, but this is now merged in the idea of money, and from that its modern significance of reward or payment gradually arose. Changes like this take centuries to accomplish, but others are made abruptly; when we say that "the airman *planed* to earth," we are using the verb *plane* in a new way, which was not thought of a few years ago and which is not immediately connected with its former use.

(2) The results of the use of prefixes and suffixes are endless new words with an infinite variety of meaning. From the noun *material* we do not hesitate to coin and use frequently the verb to *materialise*, in a sense which by no means covers the whole range of the noun; so the adjective *material* yields us its opposite, *immaterial*, which we commonly employ in the sense of unimportant, thus restricting its area of use in comparison with that of the original word. Similarly, *disgrace* is not now the counterpart of *grace*, as it should be; and there are many other examples of new words, formed with the aid of prefixes and suffixes, but so limited in use as to be essentially fresh words.

Words of Latin Origin

(3) The foreign words adopted into English are for the most part words of Latin origin, either taken direct from the Latin or indirectly through French. A very large proportion of the words in our dictionaries are of Latin descent: many of them have replaced Old English words which were either more clumsy or less expressive; but most of them were the answer to the demand which was felt, chiefly by comparatively learned men, for words which expressed with greater precision or greater dignity a more refined set of ideas than was conceived by the writers of O.E.

It is with a nation as with an individual: while it is ignorant, a limited vocabulary suffices; when it begins to learn, it widens its range of words in accordance with its new range of ideas.

Most of our words of direct Latin origin serve an analogous purpose; and some of them only convey their true significance to a well-read scholar. The great majority of these words have been added to English since the Renaissance period, when Latin became the basis of the higher education. A few Latin words survive from Roman times (*street*, *port*, *wall*); a few more came in with the early Church (*bishop*, *monk*, *candle*, *chalice*); but the rest, a vast crowd, belong to modern history.

French words are, of course, Latin words which have undergone the changes that come to language during centuries of use. The words are not always easy to recognise in their clipped, trimmed and syncopated forms. Words like *père*, *sûr*, do not at once recall *patrem*, *securus*. The consequence is that we have often taken in, direct from Latin, words which had already been adopted in their French guise. *Provident*, *secure*, *humane*, *concept* are the same words as *prudent*, *sure*, *human*, *conceit*; but the latter came through French, and do not retain the exact shade of meaning of their Latin originals. They have been used by the French and by us, with consequent changes to their meanings, while the Latin words were asleep.

French Influence

The effect on our grammar of the close connexion between English and French, during the centuries 1050–1450, has been indicated. To our vocabulary it added hundreds of words, among which we may note those dealing with the household (*master*, *servant*, *dinner*, *banquet*, *beef*, *venison*), or war (*battle*, *war*, *armour*), or law and government (*judge*, *justice*, *crime*, *parliament*, *county*, *duke*), all of which indicate the relations between the English and their conquerors.

Any passage from Chaucer would show another type of word for which we must hold ourselves indebted to the French—such abstract words as *virtue*, *nature*, *courage*, *pilgrimage*: Old English was poor in abstract ideas. As a writer of very considerable learning, Chaucer made use of many French words that were not adopted into the living language (e.g. *poraille*, *chevysaunce*), but on the whole he must have used words which had become alive to his countrymen: most of his numerous French words must have been as familiar at least as *depot*, *ennui*, *adroit* and such words are to-day. It will be noticed, however, that most of them retain the French accentuation on the final syllable (*vertú*, *couráges*). When the word became truly English the accent shifted to the first syllable, a custom inherent in the genius

of the language, which is operating in a similar way on modern words like *depot*.

The adoption of French words has gone on steadily ever since the Middle Ages; at times, as in the Restoration period, it has been almost a craze; and the practice has not yet ceased. Not only words, but concise and expressive phrases, denoting elegantly some simple idea, have a useful vogue: *raison d'être*, *coup de grâce*, *pur sang* are a few among many such phrases.

The study of Greek has led to the introduction of a fair number of words into the English language, but very many of them have passed through a Latin stage, in which their spelling was changed. Thus the Greek *oikonomia* passes by way of the Latinised form *oeconomia* into our present *economy*.

Additions from Greek continue in response to the constant need of new terms in science and philosophy, the Greek being an admirable language for the purpose. A Greek term like *philosophy* readily lends form to a series of useful derived words—*philosopher*, *philosophic*, *philosophical*; and its unfamiliar appearance makes it more possible to give a Greek word the precise and definite meaning required by a scientific term.

American Slang

Other languages which have contributed more or less conspicuous elements to ours are Italian, which has given us a large vocabulary of musical and artistic terms; Spanish, which brought us a few words connected with the sea and with trade and war (*cargo*, *negro*, *ambuscade*); and Dutch, which has given us some nautical terms, as well as a few other words (*landscape*, *sketch*).

Our historical connexions, commercial or political, with other European nations have been of less importance than those with France, Holland and Spain. We have very few loan-words from German, partly as a result of the conservatism of the German towards foreign influences, partly also, of course, because we share many of our root-words with the German, so that it has the fewer to give us. A few words come from Portuguese, usually names of products of the New World (*cocoa*); a few from Russian (*steppe*), and China, Japan, India, Persia, the Malay States, Turkey and Arabia.

America has passed on a few words from the Red Indians, in addition to several expressive slang words of her own (*bunkum*, *tammany*). Even the South Sea Islands have contributed *taboo* and *tattoo*.

A Rich Flexible Language

The total result of our catholic readiness thus to adopt and coin new words from any source is a language of exceptional variety and flexibility, efficient for the expression of any thoughts, grave or gay, concise or fluent, in philosophy or oratory, in styles which include at once the rugged Carlylese, the pompous Johnsonian, the polite ease of the *Spectator*, and the terse idiom of the *Pilgrim's Progress*. It has enriched our language with an abundance of partial *synonyms*, i.e. of words of almost identical meaning, which, by habit and custom, have come to differ by perhaps no more than the shade of a meaning, the recognition of which difference is, nevertheless, the secret of clear and lucid expression. The use of a vague and general term can be avoided by the choice of a narrower but more suitable synonym; it is quite unnecessary in modern English to be content with unpleasantly indefinite words, like *pretty*, *nice*, *big*, and many others, which have almost ceased to express exact ideas. The choice of the fit word is one of the first elements of style.

E. W. E.

From the painting by Thomas Stothard, R.A., in the National Gallery.

THE CANTERBURY PILGRIMS.

From the painting by Georges Rochegrosse.

HUNS SACKING A ROMAN VILLA.

The Huns, a Tartar race of barbarous fighting men, swarmed into Europe originally from Central Asia, and about the year 430, under the leadership of Attila, began seriously to match their strength against the might of Rome. (*See p.* 207.)

Continued from page 146

HISTORY:

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THE TEUTONIC INVASIONS

It will be remembered that at the end of the last lesson (p. 146) we showed how, during the reign of Constantine the Great, the first of the Christian Emperors (306–337 A.D.), the seat of government of the Roman Empire came to be transferred from Rome to Byzantium, the old Greek city on the Bosphorus, known subsequently as New Rome, then as Constantinople, or the City of Constantine.

This was an event of profound importance in the history of civilisation, for although the Roman Empire continued for some centuries to exist as the greatest Power in Europe, the change of capital rendered impracticable the old Imperial dreams of Cæsar and Augustus.

Rome's Waning Power

Rome lost and, owing to alien influences then at work, was never able to regain her proud position as the dominant city of the world. Later, it is true, as the seat of the Papacy, she became the capital of an administration greater even than that which the House of Cæsar had laboured to build, but Constantine, by deposing her from the headship of the Empire, robbed her for ever of her supreme temporal power, and thereby cleared the way for an entirely new order of political ideals.

So far back as the days of Augustus there had been much unrest among the Teutonic tribes inhabiting the wild and unexplored regions to the north-east of the Empire.

Augustus and Constantine, and the latter's successors, Constantius and Julian, all engaged in wars with these people, and repeatedly hurled them back over the borders of their dominions. But, despite such checks, the "Barbarians" steadily grew stronger, and in their quest for better settlements made their way in ever-increasing numbers into the Empire—particularly along the course of the Danube—where many entered the service of the Roman armies, being rewarded in some cases with grants of land.

These tribes were for the most part Goths, and in course of time it became by no means unusual for a Gothic chieftain to be the head of his own people and at the same time a general in the Roman army. Thus Roman civilisation and Roman law spread gradually among the Teutons long before they really had taken up their abode within the Empire; and not only Roman civilisation and Roman law, but also Christianity, the Roman religion.

In this latter connection it is important to bear in mind, for reasons which will become apparent later, that the form of Christianity adopted by the early Gothic settlers was that towards which the Emperor Constantine himself had leaned—namely, the Arian.

Arianism, so called because it was the doctrine preached by the Egyptian Presbyter, Arius, was a formidable heresy which sprang up in the Christian Church during the fourth century, and rent it in two, for Arius, while professing the Christian faith, denied the true Godhead of Jesus Christ, and converted the greater part of the Greek-speaking world to his belief.

Wandering of the Nations

The migration of the Goths alluded to above must not be regarded as an isolated phenomenon of these times. During the early centuries of the Christian era, in fact, a general state of unrest appears to have prevailed among all the less civilised peoples of the world, and the movements of the Goths and other Teutonic tribes were but a part of this great *Völkerwanderung*, or Wandering of the Nations, as the Germans call it. The Teutonic tribes were pressing westward into the Empire merely because in the east Turanian tribes—notably the Huns—were pressing into their territories; and the Huns, for their part, were pressing westward because they in turn were being driven out of China, their native land, by yet other tribes.

In the year 376 the Huns poured into the great Gothic kingdom which had been formed north of the Danube in the land that had once been the Roman province of Dacia. The Goths, unable to resist this overwhelming onslaught, were driven across the river into Roman territory; and there, after they had defeated the Emperor Valens at the battle of Hadrianople in 378, they were perforce allowed to settle.

This occurred during what was a period of great weakness in the Empire. On all sides Roman dominions were in revolt; Emperors and pseudo-Emperors were rising and falling in rapid succession; and although Theodosius the Great, who came into power in 379, saved his heritage from absolute disintegration, he was not able to prevent the Goths from establishing themselves securely in their new settlements.

Alaric, King of the Visigoths

Theodosius was the last of the Emperors to hold an indisputed sovereign sway over the united dominions of ancient Rome. On his death in 395 the Empire was again divided; and this division marks the real, though not the technical, beginning of those two Empires, which are apt to prove puzzling to the student of mediæval history—the Eastern Empire and the Western Empire, which existed more or less concurrently until 1421, when Constantinople fell into the hands of the Turks, and the Eastern Empire came to an end.

Theodosius left his dominions between his two sons, Arcadius and Honorius, the former taking the eastern provinces, the latter the western. At the time of their father's death the two boys were minors. Their dominions, therefore, were governed—or rather, misgoverned—in their names by the ambitious, self-seeking soldiers and officials who thronged the Imperial court, and whose feuds and quarrels afforded the barbarians easy opportunities for fresh incursions.

Invaders began now to sweep over the borders of the Empire—not only along the course of the Danube, but also along that of the Rhine—and in many cases the tribes were led by chiefs who had learned the art of war as soldiers in the service of Rome. Pre-eminent among these chiefs was Alaric, the great king of the Visigoths, or West Goths, who revolted in the very year that Theodosius died; then, having over-run Greece, marched westward, and led his army into the heart of Italy.

For awhile Alaric was held in check by the Roman general Stilicho, himself a man of Teutonic blood. The successes of Stilicho, however, aroused the fears and suspicions of the Emperor's courtiers. A conspiracy was hatched against the general, and Honorius was finally persuaded to condemn him to death on a groundless charge of treason.

This act of base ingratitude on the part of the decadent boy Emperor towards the man who more than once had saved his throne from destruction met with its own reward. It was in August, 408, that Honorius sentenced Stilicho to death. In the October of that same year, Alaric, now an all-conquering invader, appeared before the walls of Rome; and in 410 took, and allowed his soldiers freely to plunder, the proud Imperial city through whose streets no foreign enemy had passed since those mythical days when (*see* Chapter II., page 76) Rome fell into the hands of the Gauls from Northern Italy.

Laden with treasure, and accompanied by long trains of captives, the Goths then made their way southward, and were about to cross into Sicily when Alaric died suddenly at Consentia in Bruttium. His successor, Athaulf, made peace with Rome, and having married one of the Emperor's sisters, passed on into Spain—not as an invader, but avowedly to restore that province to the Empire.

In reality, of course, this was the beginning of an independent Gothic kingdom in Spain; and the way in which it began "is," writes Dr. Freeman, "a good example of the way in which the Roman Empire, its laws and titles, still exercised a powerful influence on the minds of those who were really its conquerors."

Attila and his Huns

Meanwhile, farther north, along the frontier of Gaul, other Teutonic tribes—Franks, Burgundians, and Vandals—were everywhere breaking into the Empire. These migrations barely affected the Eastern Empire, but, despite this, the East could do nothing to assist the West, for the Emperors at Constantinople were faced at this time with the menace of a Persian invasion, and the task of repelling it taxed their resources to the utmost.

During the early part of the fifth century, however, the Romans of both Empires, together with the Goths and other Teutonic tribes, settled within their boundaries, were all brought together and forced to unite in order to meet a new and common danger.

Mention has already been made of the Huns, the Turanian, or Tartar, nation which towards the end of the fourth century sud-

denly appeared to the north of the Danube, and drove the Goths over that river into the Empire. Now, about the year 430, the Huns again appeared in Europe, and this time, under the leadership of Attila, the most famous and most terrible, perhaps, of all the warriors whose deeds History has recorded, prepared in earnest to measure their strength against the might of Rome.

The Huns were a nomadic people, consisting almost entirely of fighting men and

From the painting by A. De.ug.

THE DEATH OF ALARIC.

The great Gothic warrior died suddenly at Consentia in Bruttium (A.D. 410) while leaving Italy after he had sacked the city of Rome.

shepherds, who came originally from the wide eastern plateau of Central Asia. So far as physical characteristics are concerned, they bore a close resemblance to the modern Chinese, who, as a matter of fact, are descended from the same stock; as also are the Finns, the Magyars of Hungary, and the Turks.

Early historians have ascribed almost supernatural qualities to Attila, King of the Huns; whilst even to-day he is commonly represented as a prodigy of wickedness. But both his power and his wickedness have probably been exaggerated by legend.

When his designs required, or when he thought they required, an exhibition of cruelty, Attila encouraged his men in remorseless plundering and devastation; in his private life, on the other hand, he was a man of simple tastes, frugal in the extreme; whilst among his own subjects he earned for himself the reputation of being a fair and impartial dispenser of justice.

"Attila," writes Dean Church, "was the exact prototype and forerunner of the Turkish chiefs of the house of Othman. In his profound hatred of civilised men, in his scorn of their knowledge, their arts, their habits and religion . . . in his insatiate and indiscriminate destructiveness, in the cunning which veiled itself under rudeness, in his extravagant arrogance and audacious pretensions, in his sensuality, in his unscrupulous and far-reaching designs, . . . we see the image of the irreclaimable Turkish barbarians who ten centuries later were to extinguish the civilisation of Eastern Europe.

"The attraction of Attila's daring character, and his genius for the war which nomadic tribes delight in, gave him absolute ascendancy over his nation, and . . . like other conquerors of his race, he imagined and attempted an empire of ravage and desolation, a vast hunting ground and preserve, in which men and their works should supply the objects and zest of the chase."

This remarkable warrior-king, who bragged that wherever his horse's hoofs once touched the ground the grass would never grow again,

came into power on the death of his father in the year 434.

It was not until 441 that he made an attack on the Roman Empire, but from that time for several years to come the Illyrian provinces suffered terribly from the inroads of his barbaric armies, and the Eastern Empire would probably have been completely lost to him had not the Emperor, after failing in an attempt to procure his assassination—an attempt, by the way, which the Hun generously forgave—at length obtained peace by ceding a large territory south of the Danube.

This happened in 499. Two years later Attila found occasion to interest himself in the affairs of Western Europe. It came about in this way.

On the death of Clodion, King of the Franks—a Teutonic people who, as we have shown, were already spreading into the Empire across the Rhine, and who had recently extended their power into the land now known as Belgium—the succession to the throne fell into dispute among the late king's sons. The Romans lent their support to the younger; and the elder, determined not to surrender his claim, appealed to Attila for help.

The King of the Huns at once set out at the head of a large army, and having marched across Europe, a distance of 700 or 800 miles, plundering and destroying as he went, reached the Rhine, where he divided his army into two parts, uniting one with the Franks, while he himself with the main body pushed on towards the Loire.

Battle of the Marne

An adroit movement on the part of Aetius, the Roman general, forced the barbarian to abandon the siege of Orleans and to retreat towards the Marne. Attila took up a position near Chalons, and was there vigorously attacked by the armies of Aetius and of Theodoric, King of the Visigoths.

The great battle that followed was perhaps the most momentous ever fought. It was the supreme struggle between the Aryan and Turanian races, between Christianity and savagery; and, happily for the future of Europe, the forces of civilisation triumphed.

Chalons is often described as the most decisive battle in the history of the world. And it is true that this victory saved Gaul for ever from the danger of Tartar domination; none the less, although it immediately weakened the military resources of the terrible Hun, it did not bring his meteoric career to an immediate end.

Having extracted his army with consummate skill from a truly perilous position, Attila succeeded in escaping southward. Then he made his way over the Alps into Italy, where he continued his work of terrorisation and destruction until, having ravaged the plains of Lombardy with fire and sword, he marched boldly against Rome.

But his army, weakened by exhaustion and disease, was not in a condition to attack a strongly fortified city. No one realised this more fully than Attila himself. The Hun, therefore, was pleased almost graciously to receive the mission, headed by Leo the Great, Bishop of Rome, which came to him to sue for peace; and, having demanded as the price of his withdrawal that one of the Emperor's daughters should be added to the number of his many wives, agreed to depart from Italy.

Death of Attila

Soon after he had set out, Attila was struck down by some sudden, mysterious illness, and died that night. The immense empire over which he had established his control then crumbled immediately, for it had no territorial basis, no established form of government, nor did it contain anyone strong enough to complete the work of the men who became known in the territories he conquered as the *Scourge of God*.

Although the overthrowal of the Huns made it possible for the civilisation of Western Europe to be preserved, Rome was by no means liberated from her troubles. The truth is that, as an administrative machine, the Imperial city had degenerated into a state of utter inefficiency, and had become a mere plaything in the hands of the various Teuton chieftains. The Emperors themselves were helpless puppets; and during the fifth century their position, ignoble in the extreme, went rapidly from bad to worse.

In 475 Romulus Augustus—or Augustulus, to give him the derisive nickname by which he is more commonly known—ascended the throne.

This weak, inoffensive, well-meaning man, who by some strange irony bore the name of the alleged founder of Rome, and that of the founder of the Empire, was the last of the Emperors of the West. Soon after his accession he fell into the power of the great Teuton chieftain, Odoacer, to whom in 476 he formally surrendered his prerogatives.

J. A. B.

Continued from page 162.

SCIENCES:

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CHEMISTRY.—IV

The Isolation of Oxygen.—We isolated nitrogen from the air by burning phosphorus, the phosphoric oxide dissolving in the water. A similar method for separating oxygen from air is impossible, because burning substances always combine with the oxygen and leave the nitrogen—never *vice versâ*. We must, therefore, look elsewhere for a substance containing oxygen.

We know that all oxides contain it. Perhaps these, or some of these, would part with oxygen if they were strongly heated. Since the oxides were for the most part formed at high temperatures, it will be necessary to subject them to a very high temperature in order to induce the oxygen to part company with the metal or other substance to which it is united.

And how could we recognise oxygen if it were given off ?

We should, of course, be able to observe if the oxide lost in weight, but weighing is unnecessary because it is simpler to see if a gas is evolved which would support combustion. Oxygen mixed with the inactive nitrogen in the air supports combustion ; alone it should enable substances to burn vigorously, e.g. re-kindle a spark on a piece of wood.

Experiment XIV.—*To attempt to isolate oxygen by strongly heating oxides.*

The oxides of the following metals are suitable for this purpose : magnesium, zinc, iron, copper, mercury, lead.

A little oxide is placed in a small tube of hard glass sealed at one end and held in a very hot flame with a glowing chip of wood near the open end ; if oxygen is evolved the wood will re-ignite. Of the oxides named, only mercuric oxide and red-lead evolve the gas, but several of them undergo physical changes, e.g. litharge darkens and melts, zinc oxide goes yellow and becomes incandescent, mercuric oxide goes black, and then yields oxygen and a mirror of metallic mercury upon the cooler parts of the tube. Red-lead also darkens, and, as it begins to melt, oxygen comes off, leaving a residue of a greenish-yellow colour, which is chemically identical with litharge.

Now, both mercury and lead can be burnt and their oxides obtained in this way. Therefore, the oxygen derived from the oxides comes originally from the air.

On the manufacturing scale oxygen was formerly derived from the air by means of *Brin's Process.* A white earthy powder, very much like quicklime, called baryta, or barium monoxide, was heated to about 700° C. in vertical iron cylinders, traversed by a current of purified air.

Under these conditions the baryta unites with atmospheric oxygen to form another oxide, richer in oxygen, called barium dioxide. This added quantity of oxygen can be expelled from the dioxide by raising the temperature, but, industrially, it was obtained by reducing the pressure : the air-current is turned off and the cylinders are connected to an air-pump, the temperature not being altered. The baryta left is then used over again.

At the present time oxygen is obtained by liquefying air (i.e. converting it into a liquid by applying high pressure at a very low temperature), and allowing the admixed liquid nitrogen to boil away.

Combination and Decomposition.—Having now studied a number of simple chemical changes, we are in a position to classify them.

The changes involved in acts of combustion are all of the type A + B = A B, thus, e.g., copper + oxygen = copper oxide ; barium monoxide + oxygen = barium dioxide.

These are examples of *Combination* or *Synthesis.*

The action of heat upon mercuric oxide typifies the reverse process, called *Decomposition* or *Analysis.*

A B = A + B

Thus mercuric oxide = mercury + oxygen.

A great number of chemical changes belongs to one or other of these two classes.

The Preparation and Properties of Oxygen.—The three substances already mentioned which evolve oxygen on being heated are not suitable for making the gas in the laboratory. They are either too expensive, require a great deal

of heat, or yield too little oxygen. The substance invariably used is *potassium chlorate*, a white crystalline solid which is also employed for making match-heads, throat lozenges and fireworks.

It has already been stated that chemistry is pre-eminently a *practical* science, and any chemical student worthy of the name must know how to build up such a simple piece of apparatus as that used in making oxygen.

The first essentials are the cutting and bending of glass tubes and the boring and preparation of corks.

To cut, or, more accurately, to break, a piece of ordinary soft glass tubing, it is damped at the spot where the fracture is to be made, and then given a clean scratch with a *sharp* triangular file. The

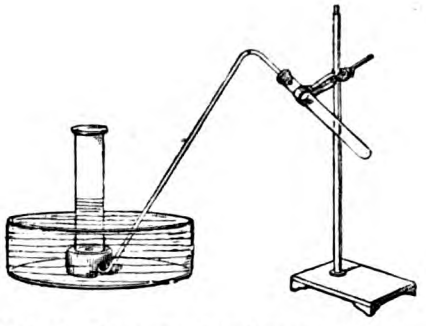


Fig. 5.—Apparatus for Preparing Oxygen.

tube is then grasped by the thumb and fingers of each hand, with the scratch uppermost. A gentle circular downward motion by the hands causes the tube to snap in two, leaving regular but very sharp edges.

The latter must then be "rounded off" by holding them for a few seconds in a hot flame; the glass will begin to melt and so lose its sharp edges.

To bend glass tubing, an old-fashioned *batswing* flame must be used. The tube is held lightly in a horizontal position between the thumb and three first fingers of each hand (the palms being turned towards the manipulator), and as the centre portion is heated in the flame it is moved round and round until it becomes quite soft.

It may then be taken out of the flame and bent into the required shape; or it may be kept in the flame—but not rotated—and allowed to bend by its own weight. The deposit of soot upon it must be left until it has cooled down, when it is easily removed with soft paper.

The layer of soot helps to anneal the glass, i.e. prevents it cooling too quickly.

A cork is then selected with a diameter a little greater than that of the test-tube. It is first made thoroughly soft by means of a cork-press, and then rounded by rolling it under-foot wrapped up in paper. Its diameter will then correspond to that of the test-tube.

A sharp cork-borer is then taken with a diameter a little less than that of the glass tube to be used, and with it a hole is bored vertically downwards through the centre of the cork. When nearly through, the cork is rested on the bench and the motion continued until the cork is perforated; in this way the borer comes through cleanly without leaving jagged edges.

The hole through the cork can then be trimmed by means of a rat-tail file. The glass tube is inserted into the bored cork with a screwing movement. If it is necessary *to cut a cork*, a sharp knife moistened with water should be used. When a very well fitting cork is essential, it should be softened, prior to being bored, by immersing it for some time in boiling water.

Experiment XV.—(*a*) *To find the Action of Heat upon Potassium Chlorate.*

A little chlorate is heated in a small hard glass tube. It melts, effervesces owing to the escape of oxygen, and then solidifies. On continuing to apply heat, the solidified substance evolves more oxygen, and finally sets to a hard white crystalline mass called potassium chloride.

Potassium chlorate = oxygen + potassium chloride.

(*b*) *To find the weight of oxygen obtained from 100 grams of potassium chlorate.*

This experiment is a repetition of (*a*), only a larger tube must be used, and both it and the chlorate must be weighed. About 1 gram of dry chlorate should be taken, and it must be carefully heated so that no white fumes escape. In order to expel all the oxygen, the final heating must be intense. The chloride left should have been melted, otherwise there may still be oxygen unexpelled. An alternative plan is to heat, cool and weigh the tube and contents until the weight no longer changes, a process called "getting a constant weight."

(2)	Weight of tube and potassium chlorate	13·631 gm.
(1)	Weight of tube alone	12·706 gm.
	Pot. chlorate	0·925 gm.
(2)	Weight of tube and potassium chlorate	13·631 gm.
(3)	Weight of tube and potassium chloride	13·260 gm.
	Loss (oxygen)	0·371 gm.

Since 0·925 gm. of chlorate gave 0·371 gm. of oxygen,

1 gm. „ would give $\frac{0{\cdot}371}{0{\cdot}925}$ gm. „

And ∴ 100 gm. „ „ „ $\frac{100 \times 0{\cdot}371}{0{\cdot}925}$ gm.

= 40·1 gm.

Very accurate experiments give a loss of 39·37 per cent.

Similar experiments may be performed with mercuric oxide and red-lead. These yield respectively 7·4 and 2·33 per cent. of oxygen.

Although potassium chlorate contains much oxygen, it does not give it off very readily. If it be previously mixed with sand, iron oxide, or with manganese dioxide, the evolution of oxygen is much accelerated.

Experiment XVI.—*To make oxygen for use in the laboratory.*

Some potassium chlorate is melted in a hard glass tube and then a little powdered manganese dioxide added. A violent effervescence at once takes place and oxygen comes off in large quantities.

By treatment with water the potassium chloride

left can be dissolved out of the black residue, leaving the manganese dioxide in an unchanged condition.

Substances like sand, manganese dioxide, etc., which accelerate a chemical action without changing themselves, are called "*catalysts*." Their action has been aptly compared with that of oil on a bicycle. The oil does not make the bicycle move, but it facilitates the motion when it has once started.

Oxygen is usually prepared from a mixture of about four to five parts of chlorate and one of manganese dioxide. It is important that the latter should be free from foreign matter, particularly from dust, as this might take fire during the course of the preparation, and cause an explosion.

The apparatus consists of a test-tube fitted with a cork and delivery tube which passes down under a beehive-shelf in a trough of water. A gas-jar filled with water, and standing in an inverted position on the beehive-shelf, serves as the receptacle for the evolved oxygen, this gas displacing the water as it enters.

About two-thirds of the test-tube is filled with the mixture, a strip of soft paper is wound round the top and this part is then clamped to a retort-stand. Care must be exercised both in clamping and in heating the tube as it is made of thin and soft, i.e. easily fusible, glass. The flame employed should be about 3 inches high and slightly luminous at the top; it must be held in the hand and gently moved about under and round the test-tube, the upper part of the mixture being heated first. (*Why?*)

It is better to use a test-tube than a flask or hard glass tube, because, owing to its fragility it demands greater care and manipulative dexterity on the part of the experimenter.

The first bubbles of gas which appear in the trough consist of air, and should be allowed to escape.

When a sample of the gas, collected in a test-tube, will re-kindle a glowing spark, the inverted gas-jar filled with water is placed on the beehive-shelf and the oxygen collected. When the jar is full a glass disc is placed over its open end, and it is then withdrawn. In this way some six or more jars can be filled with the gas from the amount of mixture used. When the collection is finished, the delivery tube must be removed from the water before the flame is taken away. (*Why?*)

Oxygen is a colourless, invisible gas, and when pure it is also tasteless and odourless. It dissolves to a slight extent in water.

(*a*) A glowing spark plunged into the gas at once bursts into flame, and if the jar be inclined downwards and the spark held below, it will re-ignite, showing that oxygen can be poured downwards, and is, therefore, heavier than air.

(*b*) Into a second jar a lighted candle is introduced on a deflagrating spoon. It burns with a very bright flame, and is consumed very quickly, and the jar becomes noticeably hot.

(*c*) A small lump of wood charcoal is put in a deflagrating spoon and held in a flame until a spark remains on it. Plunged into oxygen, it immediately brightens and throws off sparks: a small flame will be apparent. In this case the carbon (charcoal is one of several forms of carbon) unites with the oxygen to form a colourless gas, carbon dioxide. If the latter be shaken up with water and some blue litmus * added, a weak red colour will develop—due to carbonic acid. Carbon + oxygen = carbon dioxide. Carbon dioxide + water = carbonic acid.

Since all fuels contain carbon, carbon dioxide is always being discharged into the air; at the same time the air is deprived of oxygen.

(*d*) Sulphur, heated in a deflagrating spoon until it catches fire, is lowered into oxygen. It burns with a bright lilac-coloured flame, forming a colourless gas with a peculiar smell—sulphur dioxide—and some white fumes. Sulphur + oxygen = sulphur dioxide. On shaking with water, sulphurous acid is produced. Sulphur dioxide + water = sulphurous acid.

(*e*) Phosphorus may be burnt in a similar manner. It gives an extremely brilliant light, a high temperature is produced and the characteristic white fumes of phosphoric oxide make their appearance. Phosphorus + oxygen = phosphoric oxide. Phosphoric oxide + water = phosphoric acid.

Combustion of Metals in Oxygen.—The following additional experiments should be performed:—

(*α*) When a lighted strip of magnesium is lowered into a jar of oxygen, the light produced is so intense that the eyes are nearly blinded for some time afterwards. The white oxide formed is identical with that produced when the metal is burnt in air. Magnesium + oxygen = magnesium oxide. If a little oxide be placed on a strip of moist blue litmus paper no reddening occurs; on the other hand red litmus is turned blue, indicating that magnesium oxide and water unite to form an alkali.

The properties of alkalis are almost exactly opposite to those of acids. Instead of a sour taste they have a bitter one, they act differently on litmus and on other "indicators." Some of them are "caustic," i.e. they burn the skin, by dissolving the cuticle.

(*β*) The metal sodium, which is kept under oil because it tarnishes very rapidly in the air, burns in oxygen with a bright yellow flame and produces white solid fumes of oxide, or, rather, of a mixture of oxides. This dissolves easily in water, unites with it and forms a strong alkali caustic soda.

(*γ*) To burn iron in oxygen, a spiral of clean iron wire is suspended from a deflagrating spoon from which the cup has been removed, and to aid its combustion a small piece of cork is attached to its lower end. A bell-jar fitted with a cork is filled with oxygen and placed in a small earthenware dish containing water. The cork is soaked in methylated spirits, ignited in a flame, and then put into the oxygen. The iron catches fire, burns brilliantly, throwing out a lot of white-hot sparks which drop into the water below. On cooling, globules of black iron oxide are found in the water. Iron + oxygen = iron oxide. Iron oxide has no action either on moist red or moist blue litmus.

(*δ*) Zinc is heated in a fireclay crucible until it has melted, and then a current of oxygen is passed into it through a piece of cast-iron gas pipe. The combustion is very vivid, and wool-like particles of zinc oxide are given off and float about in the air (hence the old name of "philosophers' wool" for this oxide). Zinc and oxygen = zinc oxide. Zinc oxide turns moist red litmus blue.

We thus conclude that the oxides of non-metallic substances like carbon, sulphur and phosphorus yield acids with water, and that the oxides of metals for the most part unite with water to form alkalis. E. H. T.

* *Litmus* is a blue vegetable dye, extracted from certain kinds of plant, lichens. It is much used as a test for acids, which turn it red. Litmus paper is made by soaking absorbent paper in blue or red litmus infusion and drying.

HEAT.—III

13. Expansion of Solids.—We have now to take up more fully the question of expansion or dilatation by heat, which has important practical applications. As in solids and liquids it is very small in amount, special apparatus must be employed to show and measure it.

Let AB (Fig. 18) be a metal rod or bar, firmly clamped in a vice at A, but free to move at B. It must be rested, but not fixed, on a smooth support at C. At the back of the apparatus a sheet of cardboard is set vertically, in which is a needle x carrying a long light rod pq (a straw will do very well). pq is weighted at p and is unequally pivoted at x, so that qx is at least ten times as long as px. The cardboard is then so placed that the free end B of the rod rests against the short arm of the lever as shown in the figure.

Now if AB is heated with the bunsen flame, it expands a little and B moves to B′, pushing the lever forward as it does so. The small motion of B through BB′ leads to a large movement of q to q', which can be easily observed and measured.

The actual value of BB′ can be estimated, though not very accurately, from the proportion

$$\frac{BB'}{qq'} = \frac{Bx}{qx}.$$

If $Bx = \frac{1}{50}$ of qx, then $BB' = \frac{1}{50}$ of qq'.

Another form of apparatus is shown in Fig. 19. A is a brass flange, into the indented portion of which the steel bar B fits exactly, when it is cold. B is fitted with a wooden handle H, and can be heated in a flame. When it is hot, it no longer fits into A.

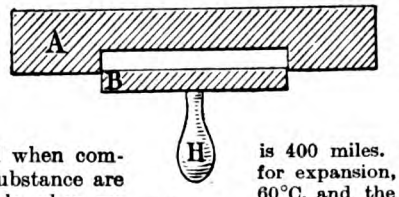


Fig. 19.

Though the expansion is small when comparatively short lengths of the substance are employed, it becomes considerable when we deal with greater lengths.

Hence, for example, the girders in bridges are never fitted quite firmly into the masonry, and gaps must be left in railway lines to prevent the rails from bending in hot weather. Allowance must be made for expansion in such diverse structures as tubular bridges and the pendulums of large clocks. Watch-springs have also to be "compensated" for the errors that would arise from their expansion. For the expansion, small as it is, takes place with great force, and cannot be resisted.

The contraction on cooling is equal to the expansion and no less forcible.

A wheelwright fits his iron rim to the cart-wheel, while it is red hot, thus taking advantage of the force with which it contracts on cooling. The following striking experiment will illustrate the same fact (see Fig. 20 (*a*) and (*b*)).

XY is a bar of iron fixed at Y, and having its free end supported in a groove on the stand A. The iron bar has a circular hole drilled in it at M, which is in such a position that the hole shows itself quite clear of A, when XY is heated. When this is accomplished, a short bar of cast iron, *mn*, is slipped into M, and thus, as it were, cuts off the retreat of X. Nevertheless, when the bar is cooled, it contracts with such force that *mn* is snapped in two.

14. Coefficient of Expansion.—In making measurements of expansion, it is a necessary convenience to reduce our results into a form which makes them serviceable for future use. This is done by calculating from our observations the amount that unit length would expand when heated 1°C.

Thus, suppose a brass rod, 120 cm. long at 0°, was found to be 120·23 cm. at 100°C. It is clear that 120 cm. have increased 0·23 cm. when heated 100°. Hence, 1 cm. would have increased $\frac{0{\cdot}23}{120}$ cm.

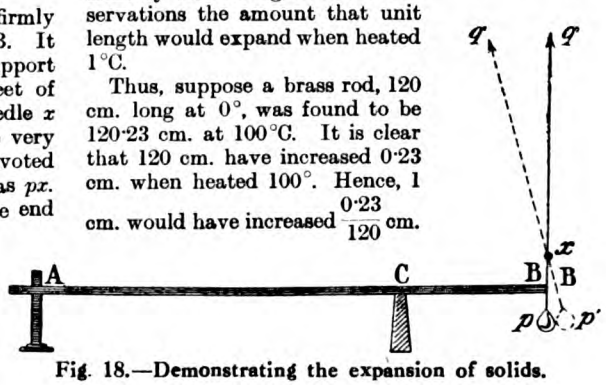


Fig. 18.—Demonstrating the expansion of solids.

for 100°, i.e. $\frac{0.23}{120 \times 100} = 0.0000192$ cm. for 1°.

This quantity, 0·0000192, is known as the coefficient of linear expansion of the brass, and clearly represents that fraction of its total length at 0° that it expands for every degree it is heated. Hence,

The Coefficient of Linear Expansion of a substance is that fraction of its length at 0° that it expands for every degree it is heated.

EXAMPLE.—Suppose the distance from London to Edinburgh is 400 miles. What allowance must be made for expansion, the range of temperature being 60°C. and the coefficient of expansion of steel 0·000011 ?

The amount of expansion per degree will be $0{\cdot}000011 \times 400 \times 1760$ *yards*

∴ the amount of expansion for 60° will be $60 \times 0{\cdot}000011 \times 400 \times 1760$ *yards* $= 46{\cdot}5$ *yards* approx.

Hence, 46.5 yards must be allowed.

The linear expansion is more often needed in the case of solids than the cubical expansion, in which the whole bulk of the solid is considered, and not its length merely. But the cubical expansion must be found in the case of iron or glass vessels, for instance; and it is convenient to know that the coefficient of cubical expansion is equal to three times the linear coefficient. This is shown by the following reasoning.

Suppose we have a cube, of side 1 cm., of a substance whose coefficient of linear expansion is α. When heated 1°, the length of the side will then be $1 + \alpha$ and the volume will become $(1 + \alpha)^3$ *cc.*

But $(1 + \alpha)^3 = 1 + 3\alpha + 3\alpha^2 + \alpha^3$, and since α is itself very small, α^2 and α^3 are still smaller, and negligible.

Hence the volume of 1° will be $1 + 3\alpha$, and 3α will be the coefficient of cubical expansion: which proves our statement.

EXAMPLE.—A glass vessel at 0° holds 500 cc. of water, what ought it to hold at 80°, the coefficient of linear expansion of glass being 0·0000089 ?

The amount of expansion per degree will be $3 \times 0{\cdot}0000089 \times 500$ *cc.*

The amount of expansion for 80° will be $3 \times 0{\cdot}0000089 \times 500 \times 80$ *cc.* $= 1{\cdot}068$ *cc.*

∴ The vessel should hold at 80° 501.068 *cc.*

If we look at the table of coefficients of expansion, we shall notice that those of glass and platinum are equal, but different from those of other metals, which vary as much among themselves. This accounts for the ease with which platinum wires can be fused in glass tubes, while iron and copper cannot.

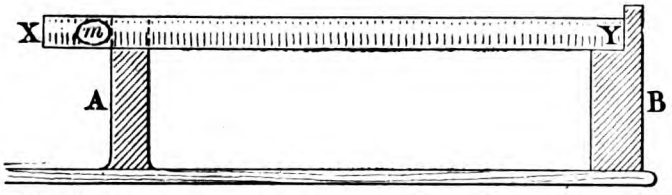


Fig. 20 (a).—Experiment to demonstrate the force with which metal contracts when cooling.

EXPERIMENTS—1. Hold the end of a piece of iron wire in a glass-tube, and melt the glass until it retains the wire. Then notice what happens on cooling.

2. Take two exactly equal strips, one of steel, the other of copper. Fit them closely on one another, so that they act as one strip. Clamp firmly at both ends, and heat the compound strip with the flame. Judge from your observation which of the two metals expands the most.

15. Measurement of Coefficient of Expansion of Solids.—This is a difficult operation for the private student to perform for himself with any degree of accuracy, and a brief explanation of a practical method employed in laboratories can alone be given here.

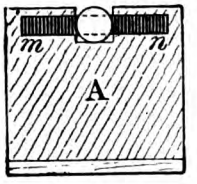


Fig. 20 (b).

AB is a metal rod with two fine marks scratched on it at A and B, the distance between which has to be accurately measured at two different temperatures. The rod is surrounded, as shown in Fig. 21, with a steam jacket, i.e. a glass tube through which a current of steam can be passed.

Two microscopes, each provided with a micrometer scale in its eyepiece, are arranged so as to view the marks, A and B, on the rod. The micrometer scale consists of a strip of glass with a very fine scale engraved on it, and the value of each division of the scale can be determined by focusing the microscope on to a millimetre scale, so that the two scales are viewed together.

The length L of AB at the temperature of the air $t°$ is first measured very carefully, after which the steam is set on. Both A and B will be seen to move through several divisions of the micrometer scale; count these, determine their value, and thus find the expansion (l) of the rod when it is heated to 100°.

The coefficient of expansion will then be found from the formula $\alpha = \dfrac{l}{L\,(100 - t)}$

If due care is taken to keep the microscopes fixed, if also allowance is made for the variation in boiling-point due to pressure, and if A and B are kept as near as possible to the steam jacket, very satisfactory results can be obtained by this method.

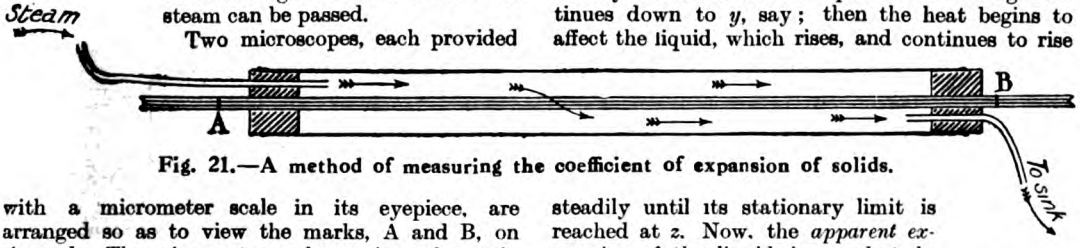


Fig. 21.—A method of measuring the coefficient of expansion of solids.

16. Expansion of Liquids.—The mercury thermometer will serve to remind us that liquids expand, as well as solids; but it must at once be noticed that the observed expansion is not the real expansion of the liquid. For the solid vessel has expanded also, and a little reflection will show that the observed expansion is less than the true expansion by the amount of the expansion of the glass. The apparatus shown in Fig. 22 will enable us to study this point carefully.

The flask A is quite filled with the liquid to be examined, and the cork carrying a long straight piece of glass-tubing is firmly pushed in. Some of the liquid is then forced up the tube to x, and no bubble of air should be visible in the flask. The position of x having been marked with a piece of adhesive paper, the flask should be plunged bodily and suddenly into a saucepan full of hot water. The immediate effect of this will be a *fall* in the level of x.

This is due to the expansion of the flask, which, being an imperfect conductor, does not instantly convey the heat to the liquid. The falling continues down to y, say; then the heat begins to affect the liquid, which rises, and continues to rise steadily until its stationary limit is reached at z. Now, the *apparent expansion* of the liquid is xz, but in fact the *real expansion* has been yz; and clearly $yz = xz + xy$: or, Real Expansion = Apparent Expansion + Expansion of Vessel.

The student should particularly endeavour to set up the apparatus just described. A 4 oz. flask and about 18 to 20 inches of glass tubing about $\frac{1}{8}$ in. wide should be used. By means of it the following further points can be elucidated:

1. The different rates of expansion of different liquids may be shown by measuring xz when the flask is filled successively with the liquids. Water, methylated spirits, glycerin and turpentine can be thus compared.

2. The irregular expansion of some liquids can also be shown. Use water, coloured with cochineal, as the liquid, and measure the height of x from the cork when the flask is placed successively in baths at 10°, 20°, and intervals of 10°, up to 90°. It will then be observed that water expands much more between 70° and 80° than between 10° and 20°—in fact nearly five times as much. The results should also be expressed graphically, as in Fig. 23.

In this diagram the vertical lines represent the position of x—i.e. its height in cms. above the cork at the temperatures indicated on the horizontal line. If the expansion of the water throughout had been at the same rate as between 10° and 20°, all the points x would have fallen on the dotted line.

17. Coefficient of Expansion of Liquids.—It is clear that the apparatus described in §16 could be used to measure the coefficient of expansion of a liquid, if that of glass is known.

But there are difficulties in the way of making the measurements accurately enough, and in applying this method it is usual to use a *weight thermometer*, in which the liquid is weighed, because it is more possible to weigh accurately to ·001 gram than to measure accurately to ·001 cc.

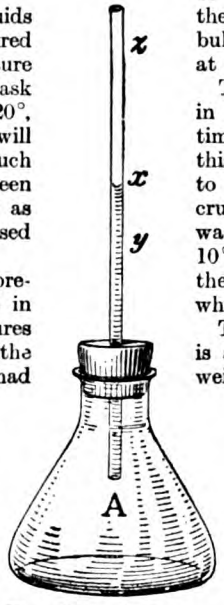


Fig. 22. — Apparatus for measuring the expansion of liquids.

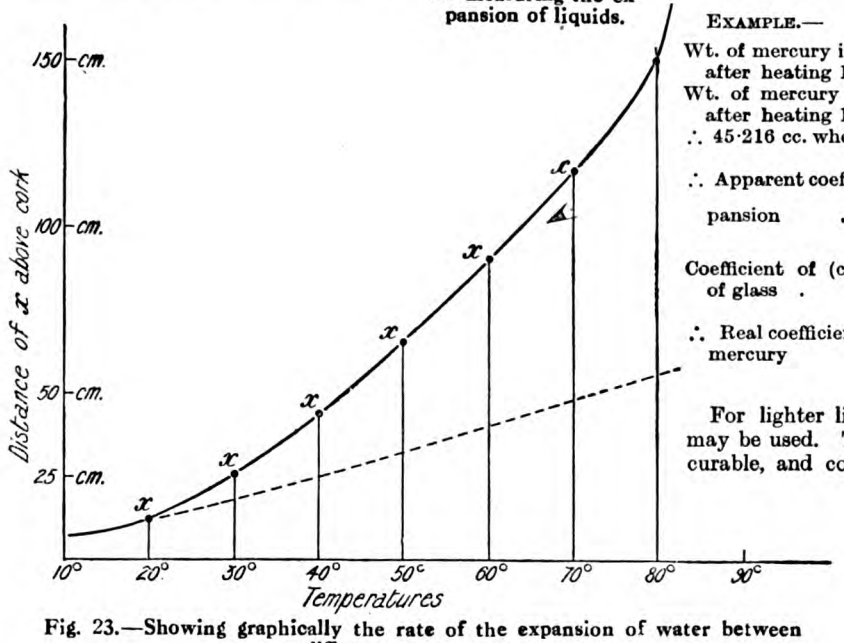


Fig. 23.—Showing graphically the rate of the expansion of water between different temperatures.

The weight thermometer consists of a glass bulb, prolonged into a tube bent twice at right angles as shown in Fig. 25. It is first weighed accurately, and then filled with mercury by the same process as is used in filling an ordinary thermometer. As the whole bulb and tube must be filled with mercury at the commencement of the experiment, it is necessary to keep the open end a in the mercury while the bulb itself is maintained for some minutes at the lowest temperature to be employed.

This is arranged by supporting the bulb in a beaker of tap-water which is several times changed. When the temperature of this water is constant, the mercury-dish is to be removed, and replaced by an empty crucible, whose weight has been found. The water in the beaker is then heated, say, 10°; some mercury is expelled from the thermometer, and collected in the crucible, which is again weighed.

The thermometer, taken out of the water, is also weighed, and thus we can find the weight both of the mercury remaining in the thermometer and of that which has been expelled. But these weights are proportional to the volumes of the mercury at the same temperature; hence we can find the apparent coefficient of expansion of mercury in glass. Add to this the (cubical) coefficient of expansion of glass, and we obtain the real coefficient of expansion of mercury.

EXAMPLE.—

Wt. of mercury in Wt. Therm. after heating 10° .	= 45·216 grs.
Wt. of mercury driven out after heating 10° .	= 0·069 grs.
∴ 45·216 cc. when heated 1° expand	0·0069 cc.
∴ Apparent coefficient of expansion . .	= 0·0069 / 45·216
	= 0·000153
Coefficient of (cubical) exp. of glass . . .	= 0·000027
∴ Real coefficient of exp. of mercury . .	= 0·000180

For lighter liquids a density bottle may be used. This is very easily procurable, and consists of a small flask (Fig. 24) provided with a well-fitted glass stopper which is perforated by a small hole. If the bottle is filled with the liquid and the stopper inserted, the excess liquid is pushed out through the hole and the bottle is quite full.

In order to perform the experiment, first find the weight of the dry, empty bottle and stopper; then fill with the liquid (say, glycerin) at a known temperature, and weigh again. This gives the weight of glycerin in the bottle at that temperature. Now immerse the bottle completely in water at a

higher temperature; leave for a few moments, until as much of the glycerin is driven out as can be. Then remove the bottle, dry it, and weigh again.

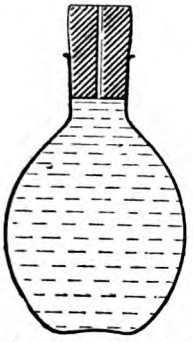


Fig. 24.—Density bottle.

EXAMPLE.—

Weight of bottle alone .. = 17·341 grs.
Wt. of bottle + glycerin at 12° = 57·453 grs.
∴ Wt. of glycerin at 12° .. = 40·112 grs.
Wt. of bottle + glycerin at 22° = 57·261 grs.
∴ Wt. of glycerin at 22° = 39·920 grs.
∴ Wt. of glycerin driven out between 12° and 22° .. = 0·192 grs.

Now, the space occupied by 39·920 grs. at 12° increases, when the glycerin is heated 10°, to that which *was* occupied by 40·112 grs.

Hence, 39·920 cc. when heated 10° would expand 0·192 cc.

$$\therefore \text{ (apparent) coeff. of exp. of glycerin} = \frac{0{\cdot}192}{10 \times 39{\cdot}920} = \underline{\underline{0{\cdot}00481}}$$

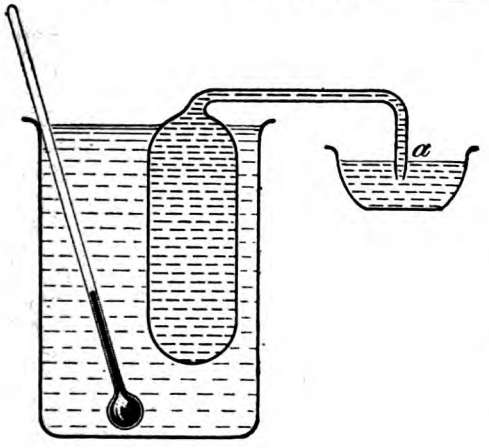


Fig. 25.—A weight thermometer.

COEFFICIENTS OF EXPANSION

Brass	·0000189		Linear
Copper	·0000167		,,
Iron	·0000117		,,
Steel	·0000110		,,
Glass	·0000089		,,
Platinum	·0000089		,,
Mercury	·00018	Between 0°	to 100°
Alcohol	·00109	,, 0°	,, 50°
Glycerin	·005	,, 0°	,, 50°

Is should be observed that the method of calculation employed here implies a small error; we ought to know the volume at 0° instead of the volume at 12° if we are to obtain the most accurate result. The error introduced, however, is very slight.

E. W. E.

ZOOLOGY.— V

IT is possible that many people in an average company would be in difficulties if asked off-hand to describe the place in nature of the bat.

Old-fashioned naturalists unblushingly classed bats with birds. Our rural folk were wiser than their mentors. They called the bat "flittermouse," and in Germany precisely the same name appears in "fledermaus."

Unlike the majority of local names, this is an apt one, yet it is treacherous. It suggests that the bat is a sort of winged mouse, a flying rodent. The nickname should imply really a winged shrew or other insect-eater, for all British bats, indeed all European bats, are insectivores; whilst there are the fruit-eating bats of Australasia, of Southern Asia, of Madagascar and of parts of Africa; and the vampire bats of the New World. Still, the name serves a purpose in reminding us that the bat is no bird, but a winged mammal.

There are other so-called flying animals, both reptile and mammal, but in these instances a parachute-like extension of the skin enables the possessor to skim through the air after starting from a height. Bats are the only true flying mammals.

Flying Mammals

They date from early geological times. Insects were the first creatures to fly; amphibians, those dragons dire, followed them, to give rise in time to birds. From some terrestrial form of insect-eating mammal bats were evolved.

They were formerly classed with the Primates, the highest order of animal life, but now they occupy the second order in the table. In spite of extreme specialisation, they retain many evidences of affinity with the insectivores. Their contemptible brains still associate them with the lowliest forms of mammalian life, but structural characteristics fix for all time the position which they must be accorded in the scheme of zoology.

Whales and seals converted their hands into flippers and paddles; birds modified theirs into wings, and changed their scales for feathers. Bats retained their mammalian hair and exchanged their hands for a primitive type of wing. The thumb and fingers, the wrist and arm-bones still exist. But from the shoulder and the sides of the body there springs a highly sensitive skin, which links together the four fingers, leaving the thumb

to act as a claw or hook; and either includes the hind legs and prehensile feet and the tail, or leaves these free.

The great wing of the bat is strung upon the four fingers of the hand and upon the upper and lower arm and attached to the flanks. The upper arm is much shortened, the lower arm is immensely extended, and the fingers are correspondingly elongated. But there, unmistakable, are the arm and hand. Each wing expands and folds up like an umbrella; the integument extends along the side of the body to the hind-quarters to secure additional buoyancy; the bones of the arms and legs are light and hollow, the place of the solid substance being taken by marrow—and there we have Nature's highest yet in the scheme of flying mammals.

The great gift thus acquired has not been secured without cost. The bat, descended from ancestors which progressed by an all-fours method, has largely sacrificed the means of making progress upon a level surface. There is an exception in the remarkable thyroptera of South America, which, having developed upon the thumb and foot sucker-discs, suggesting those of the octopus, can, like the gecko, run up smooth surfaces. The others, however, with the knee turned backwards in order to give support to the wing membrane, crawl laboriously, with the wings folded beside the body, clawing themselves forward by gripping any inequality which the surface may afford.

How Bats See

This applies, of course, only to movement on the ground or similar resting place; for upon the limb of a tree or upon a beam, bats clamber about after the manner of sloths, hanging by their hook-like claws, by means of which instruments they support themselves, head downwards as a rule, when sleeping or hibernating.

Bats are practically all nocturnal in habit, though the flying foxes return from their raids when the sun is up. In the majority the eyes are very small; some, indeed, have these organs barely functional. As compensation they have the most highly specialised skins of any animal.

When a blind man tells us that he "feels" his way about, he means that he is guided by impressions received by the sensitive skin of his face. That tactile sense which distinguishes him is immensely developed in the bat, in the skin of the wings, in the skin of the ears and in the sensitive and exaggerated tragus (the fleshy pad guarding the entrance to the inner ear), and in extraordinary fleshy developments, resembling leaves and flowers springing from the muzzle and sometimes from the lower lip. The unparalleled delicacy of the tactile senses of the bat has been proved in a thousand ways, but one terrible experiment, which deprived bats of sight, of smell and of hearing, demonstrated it conclusively.

Mutilated as they were, bats flew about a room crossed by many threads of silk, through narrow winding passages, their path barred by twigs and other obstructions. Not once did they collide, and when the obstructions were multiplied or drawn closer together, they compressed their wings and still flew unchecked.

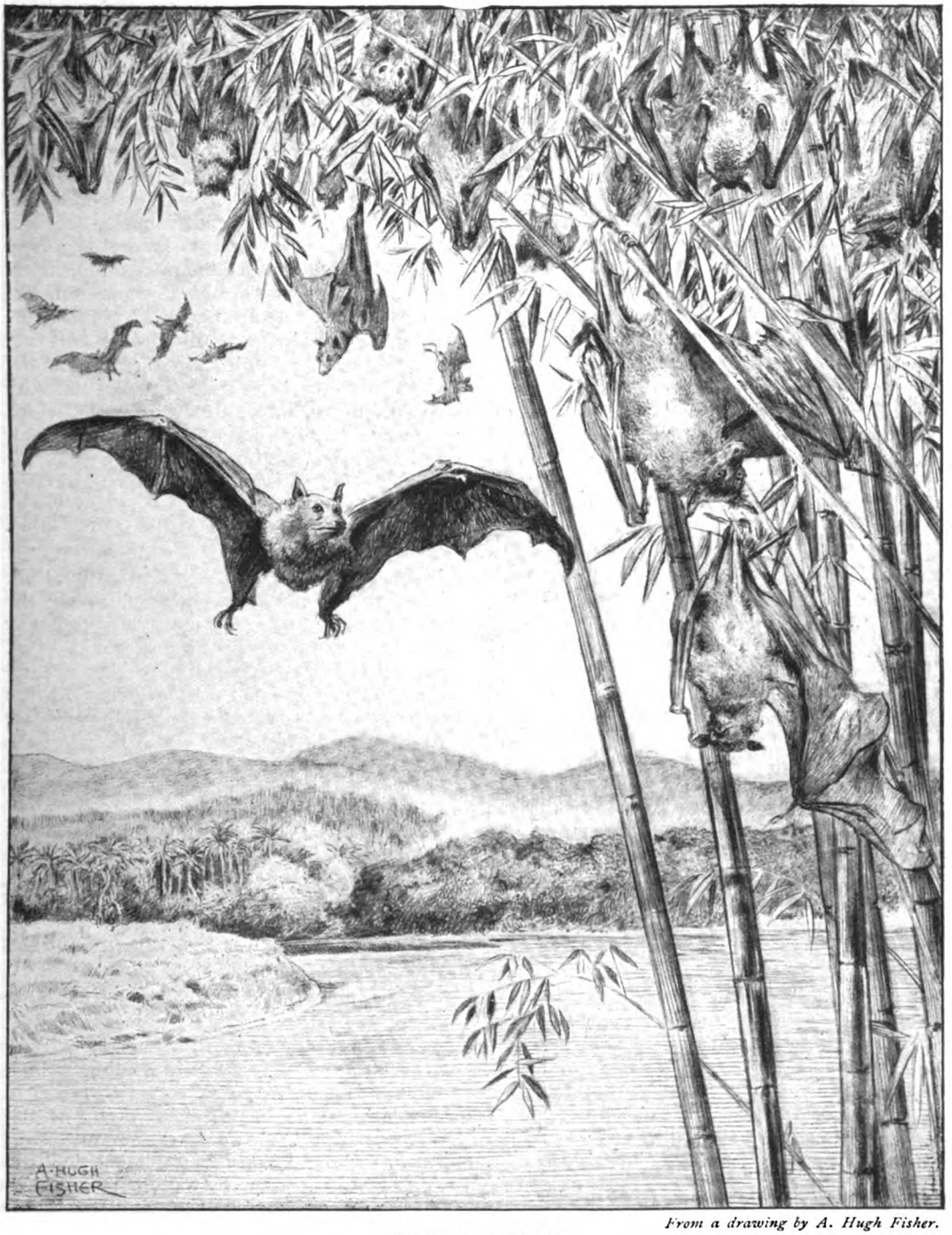
Types of Bat

All the European bats are insectivorous, therefore of immense value to us, but the flying foxes and other fruit-eating bats, when they teem, as is the case in India, near cultivated areas, are a serious nuisance. These attain their maximum dimensions in the Malay fox bat, a creature having a wing-spread of five feet from tip to tip.

Known in Australia and Southern Asia and in many oceanic islands, these animals are most common in India, where, flying in great numbers to their feeding grounds, they cover the trees to be attacked, hang themselves up by one foot, drive the claw of the other into the fruit, and so make merry. The European bat has the teeth which we should expect to find in the jaws of an insect-eater, but the fruit bat's molars, lacking the cusps of the insectivore's, and armed instead with a longitudinal ridge proper to a diet of fruit, at first suggested an independent origin. The anatomist has, however, found the connecting link. In the Solomon Islands we have the Pteralopex, a fruit bat with cusped molars, the bridge between fruit bats and insect-eating bats. All arise from a common stem.

There are hundreds of different species of bats, and necessarily we find great variety of form, size, diet and habit. In addition to the fruit-eating bats we have bats which devour flowers and blossoms, and in the Noctilio leoprinus, an American representative, one which has taken to a fish diet.

These bats were a great trial to poor Linnæus and his scheme of classification. They are what we call "hare-lipped"; they have decidedly rodent-like upper and lower jaws, and the learned Swede expelled them from the company of bats and put them with



From a drawing by A. Hugh Fisher.

FLYING FOXES

in the bamboos by the river Mahaweliganga in Ceylon, in which, according to the story, the Portuguese bishop cast the tooth of Buddha which he had taken from its shrine and ground to powder in a mortar. The bamboos, which attain the height of 120 feet, growing 12 inches a day in June and July, are infested with bats.

the hares and rabbits, the mice and beavers. Modern science has reinstated them. Though they will mumble the flesh of a young bird, and relish a cockroach, their habit is to feed upon small fish caught by dashing at the surface of water when the prey is seen.

This leads us to the more formidable bats, in the vampire group. By one of the ironies of titles the true vampire bat is not the miscreant he is represented as being. Hideous and vile in appearance he undoubtedly is, but blood-sucker, no.

His diet is almost exclusively of fruit, though a few insects may be added.

Vampire Bats

The most grim and forbidding of all the nightmare forms with which the bat world teems, the vampire is naturally credited with the crime connoted by his title. But the real blood-suckers are restricted to two genera, the desmodus and diphylla, South American types. Armed with razor-like incisor teeth, they hover above or stealthily settle on their victim, fanning gently with their noiseless wings, pare away the skin with their teeth until several small blood vessels are exposed and abraded, when the blood is drawn into the mouth and swallowed.

There is no escaping the evidence of the blood-guiltiness of these bats, for the gullet is so small that nothing but fluid could pass into it, while the stomach is adapted for the reception only of fluid. The real blood-suckers are but two or three inches in length; the maligned vampires are as big as a pigeon. Desmodus and diphylla are not, however, the only bats of carnivorous inclinations, for an Indian false vampire, Magaderma lyra, drinks the blood and eats the flesh of smaller bats.

These unpleasant habits refer, however, only to American species. There is not, beyond the confines of South and Central America, a blood-sucking bat which would attack a human being, though bats of various species are to be found in practically all parts of the world, except of course in the extreme cold of the Antarctic and Arctic regions. The British forms, the greater and lesser horseshoe, the long-eared, the barbastelle, the pipistrelle, the noctule, the hairy-armed, the serotine, the rough-legged, the natterer's, the whiskered, and some other species, whose permanent residence in the British Isles is to be doubted, are all free from offence as residents, although, as they are all incredibly verminous, they are not to be recommended as pets.

Emerging from their hiding place in belfry, tower, barn, or tree when the sun is sinking, they hawk for all sorts of insects, some retiring to rest when night has fully come, others continuing their questing until dawn.

Great Britain has none of the more bizarre and grotesque varieties, though the long-eared bat, as it uncurls its mighty ears from beneath its wings and rigs them over the upstanding tragi, is a picture not to be sought by people of nervous temperament. It is in tropical and sub-tropical lands, however, that the most extraordinary examples are to be found. Some are highly coloured, like butterflies; others are perfectly white.

The strangest, most repulsive, and yet perhaps the most interesting of all, is the naked bat of the Malay peninsula. All other bats are hairy, and the young, which are suckled by their mother as mice by their dam, cling to her furry covering. But the naked bat of Malay is, as its name implies, devoid of hair, save for a meagre fringe around the neck which gives it its alternative name of collared bat.

Now the habit of bats is to carry their young with them when they fly. Were the naked bat to do so in the manner of ordinary bats, the claws of the young would cause laceration of the parental flesh. But Nature, which has assented to the doffing of the furry coat, has provided a marvellous nursery. On the under-side of the body, between the armpits of this bat, is a deep pouch, and in this pouch the young is placed and carried until it is able to care for itself. As the male has a similar pouch it is inferred that in the event of there being two young bats at a birth, he would carry one while his mate carried the other.

Preying on the Wing

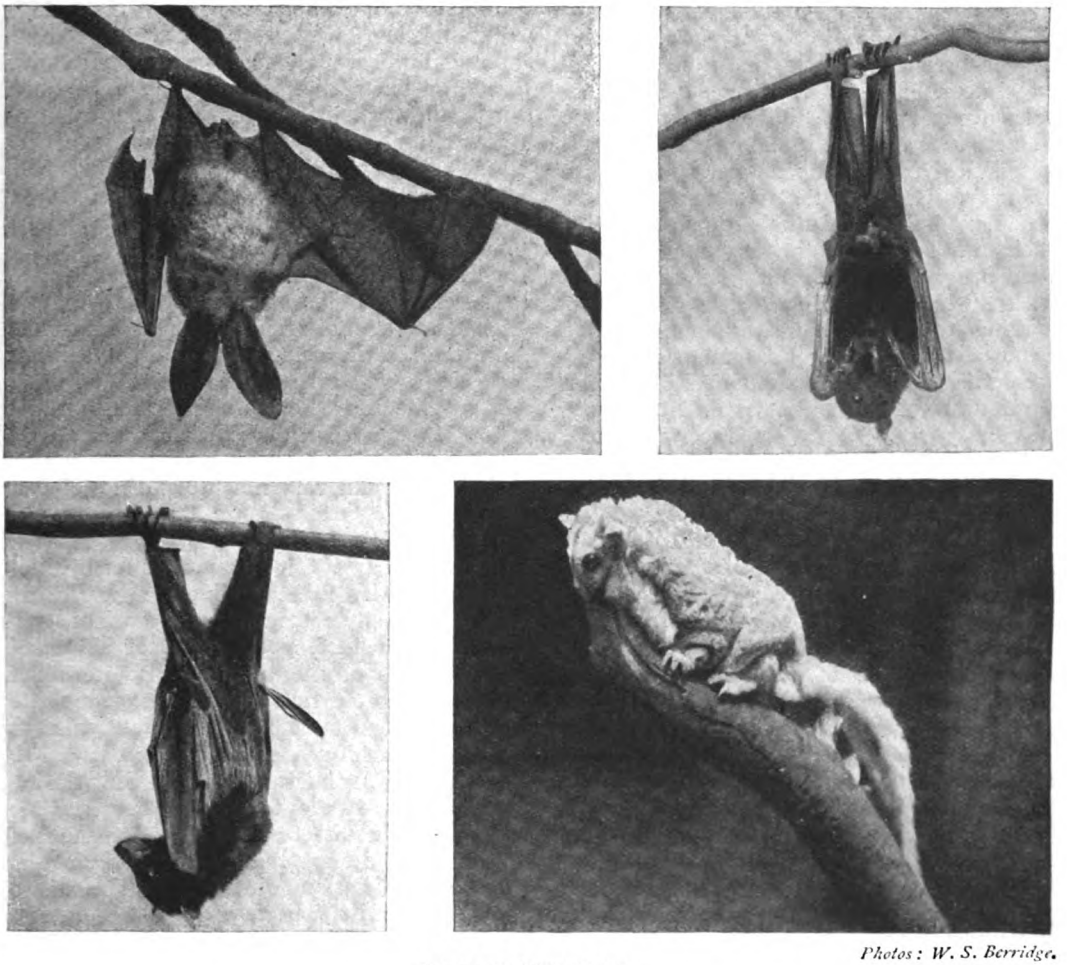
In general habits the bats resemble terrestrial insectivores. Instead of catching insects upon the ground they catch them on the wing. The careful observer, pausing in the twilight, may hear the flying animal crunching its prey as it flitters with noiseless wings around his head. The flight of the bat resembles that of a rather uncertain martin. The faltering and zig-zagging are not necessarily due to inability to keep a straight line, but are often dictated by the chase of an insect invisible to our eyes.

The great chafers—huge insects with hard horny cases—are especially relished by bats, one of which, a noctule, has been known to eat thirteen in rapid succession. Professor Thomas Bell admirably describes the noctule at work in pursuit of these insects, and adds: "An observer will not watch his movements

long without noting a manœuvre which at first looks like the falling of a tumbler pigeon, but on close observation proves to be simply a closing of the wings and a consequent drop of about a foot. It is occasioned by some large and intractable insect having been captured, and the anterior joint of the wing, with its well-armed thumb, is required to assist in retaining it."

In all the colder parts of their habitat, bats hibernate during the winter, or such part of it as is barren of food. Any appreciable rise in temperature, even if only temporary, revives the faculties and appetite of the sleeper, and sends him forth to hunt. The same heat which has aroused him has called the gnats also to life, so winter sunshine brings forth hunter and quarry together. The young of bats are born in the early summer. The mother treats her offspring with that tender care which exalts the mammalian mother above other animal parents. The little one is pressed close to the mother's furry body, which it grips with its claws, to be covered by the wing of the anxious parent. As a rule there is but one at a birth, but sometimes there are two.

But the wings of a bat—mere coverings of exquisitely sensitised skin overspreading her ghostly fingers—never fail her. Bats are repulsive in feature—replete, as to many species, with weird and repellent adornments (such, for example, as a Malayan false vampire, the Megaderma frons, which covers its wings and fur with a strange adhesive orange-coloured powder)—but they are a deeply interesting group, as the first and only mammals to attain to true flight, which to-day the aeroplane, man's supreme invention for the skies, cannot match. **E. A. B.**



Photos: W. S. Berridge.

FLYING MAMMALS.

1. Long-eared bat.
2. Malay flying fox or kalong.
3. Indian fruit bat.
4. Squirrel-like phalanger.

ASTRONOMY.—IV

It may suit primitive people very well to begin their reckoning of time when the sun rises, and dividing the time from sunrise until sunset into twelve hours, which consequently vary in length at different times of the year. But the consequent confusion would be quite intolerable in highly civilised life. We cannot even afford to reckon as noon the actual moment when the sun crosses the meridian on any day, and be content with the fact that some days are thereby longer than others. We have to set up a fictitious "mean" sun, as it is called, whose relation to the true sun is that it completes the year in exactly the same time. It is the passage of this fictitious mean sun across the meridian which may be considered as marking the instant of mean noon each day.

Sundials, on the other hand, needless to say, get their time from the actual and not from the imaginary sun, and consequently sundial time may be as much as sixteen minutes fast or slow of mean solar time. Sundials have, in consequence, fallen, or perhaps been elevated, to the position of beautiful ornaments to a garden or a house, rather than instruments of precision, and their beauty is impaired without their use to us being very much increased when they are fitted, as is sometimes done, with devices for correcting their errors and making them show mean time. Only in some of the outlying tide-gauge stations of the Indian Survey are sundials still regularly required to furnish the time.

Sundials and Moondials

There is a whole volume of interesting art connected with the graduation of sundials which will well repay the study of those interested in such matters, while the mathematically minded will find interest and some difficulty in working out what happens to the sundial which has fallen somewhat out of its level. Whatever may be the form of the dial, whether horizontal on a pillar, or vertical on the side of a house, it is essential that the edge of the gnomon should point to the pole of the sky. For that reason a sundial which is made for one latitude cannot be transported many miles north or south and continue to give true results.

If the sundial be marked as an instrument of only modern accuracy, what shall we think of the moondial, such as may be seen on the wall of the first court in Queens' College, Cambridge? That celebrated dial is adorned on its face with a number of mystical curves whose significance has puzzled successive mathematical scholars of the College. But it has in addition a table of numbers underneath which, on inspection, proves to be a table, in terms of the age of the moon, of the amounts which have to be added to or subtracted from the time shown by the moon's shadow on the dial in order to arrive at the true time. It is said that the instructed can, if they are fortunate, get the time within half an hour on this dial by moonlight. But this is perhaps an exaggeration!

Navigation and the Stars

By far the most familiar of the many daily uses of astronomy is its employment in navigation. No sooner does a sailor lose sight of land than he begins to be dependent for his position upon the sun and the stars. His reckoning by time and log will carry him perhaps in safety for two or three days; but he has always to contend with the possibility that unusual currents may have set him out of his course; and unless he is in shallow water and samples of the bottom picked up on the lead can tell him something of where he is, or at any rate of where he is not, he must soon be in a position of great disadvantage if he does not get a sight of the sun or a star.

To be able to lay down his position on the chart he wants his latitude and his longitude. The former is easy. A meridian altitude of the sun at noon, or of any star at night, will give it him with a minimum of trouble and of calculation. The observation is, of course, made with a sextant, an instrument peculiarly well designed for service at sea and very much out of its element on shore.

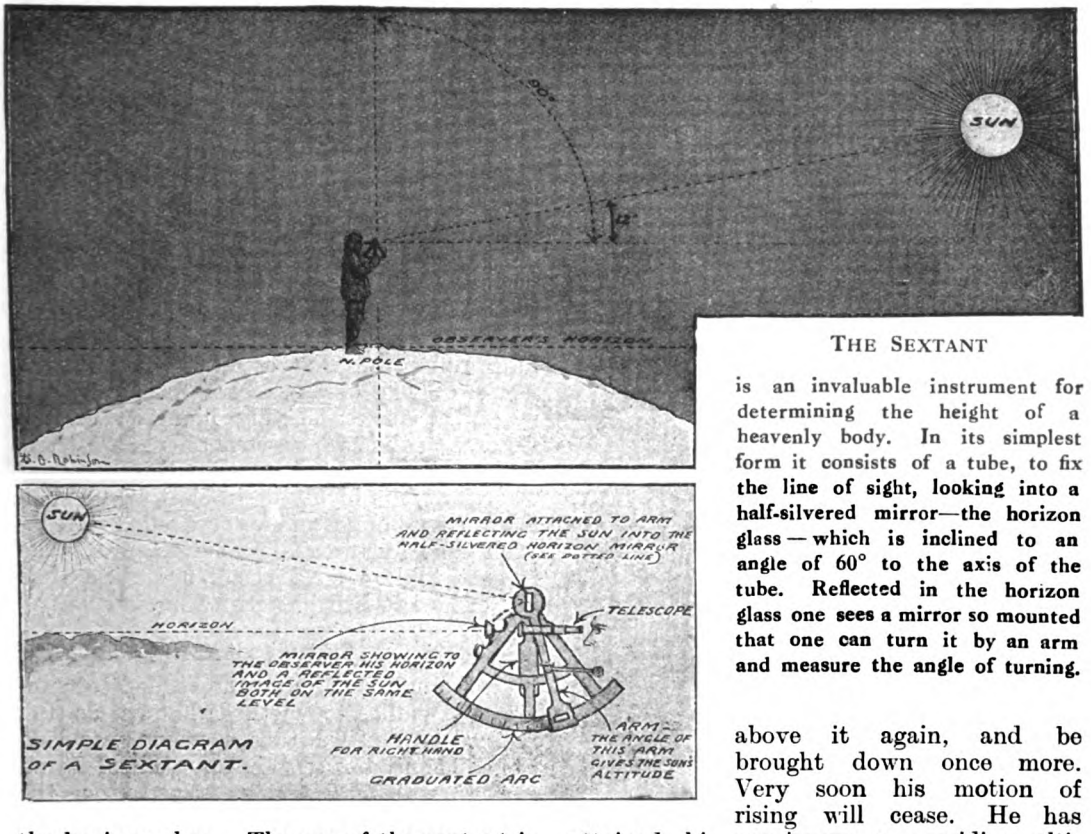
A brief description of the sextant may not be unnecessary. In its simplest form it consists of a tube, to fix the line of sight, looking into a half-silvered mirror, the horizon glass, which is inclined at an angle of about 60° to the axis of the tube. Reflected in this horizon glass one sees a larger mirror, mounted so that it can turn by an arm, and that the angle of turning can be measured.

Suppose, in the first instance, that the two mirrors are parallel to one another, and that the tube is directed towards the horizon. Through the clear half of the horizon glass one sees the horizon directly. In the silvered half one sees the horizon by reflection from the second mirror; and when the direct and reflected lines of the horizon are seen as one, then the arm should point to zero on the divided arc.

Suppose now that the arm is turned to 5°. The tube still pointing at the horizon will be able to see by the two mirrors an object twice 5° or 10° above the horizon. If the arm points to 25°, it will be possible to see the sun, which is really 50° above the horizon, brought down so that its centre apparently lies on the horizon, as viewed directly through the horizon glass. The use of the sextant is now obvious. One views the horizon through the tube and brings down the image of the sun until its lower limb seems to make contact with the horizon. The elevation of the sun above the horizon is then read on the divided arc, from the index at the end of the arm. To this one adds the angle equal to the apparent semi-diameter of the sun, taken from the Nautical Almanack; the result is the elevation of the sun's centre above the visible horizon.

To make things clearer, and to abolish the sharp division between the direction and the reflected view, it is usual to put a telescope in place of the single tube. One then sees the two parts of the view superimposed, by virtue of the fact that half an object glass is for most purposes just as good as a whole one. To mitigate the glare of the sun one has dark glasses interposed in the path of the beams, and there are various other devices with which we need not trouble ourselves.

In order to be able to get the meridian altitude of the sun the sailor sights on the sun a little before noon and brings him down to the horizon. He will soon rise above it again, and be brought down once more. Very soon his motion of rising will cease. He has attained his maximum or meridian altitude, at an angle which is read immediately from the graduated arc.



THE SEXTANT

is an invaluable instrument for determining the height of a heavenly body. In its simplest form it consists of a tube, to fix the line of sight, looking into a half-silvered mirror—the horizon glass — which is inclined to an angle of 60° to the axis of the tube. Reflected in the horizon glass one sees a mirror so mounted that one can turn it by an arm and measure the angle of turning.

To work out a latitude from this observation is quite simple. We will give the process in detail. There are four distinct steps to be made, with the help of brief tables and nautical almanacks.

1. To the observed altitude of the sun's lower limb add the semi-diameter. The result is the altitude of the sun's centre.

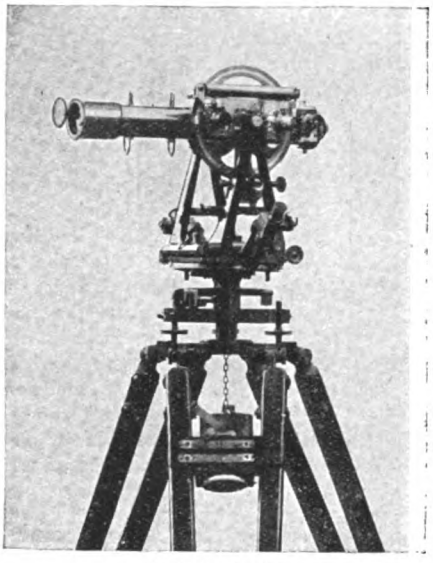
2. From this take away the refraction, which can be calculated very easily from brief tables; subtract also the dip of the horizon, due to the curvature of the earth; and add a very small correction due to the fact that the sun is not infinitely far away. The result is the corrected altitude of the sun's centre.

3. Subtract the quantity called the sun's

declination, which is the distance that the sun is north or south of the Equator at the time of the observation, and which can be calculated very easily from the tables in the Nautical Almanack. The result is the elevation of the Equator above the southern horizon.

4. Subtract this from 90° and you have the latitude of the ship.

For simplicity we have omitted the explanation of certain necessary rules, to deal with the case when the ship is south of the sun, so that the amateur navigator must not rely upon this very brief illustration, but must take the slightly more detailed



A SEXTANT.

The instrument by means of which navigators ascertain the meridian altitude of the sun at noon or any star at night.

precautions laid down for him in the technical works on navigation. The above is amply sufficient to explain the principle.

This is the familiar noon observation which is so often an object of interest to passengers at sea, since it comes at a time when everyone is on deck, and has nothing particular to do except to wait for lunch. It is a common mistake to suppose that by the noon observation the captain is determining the time of the ship. He is not; he is determining the latitude.

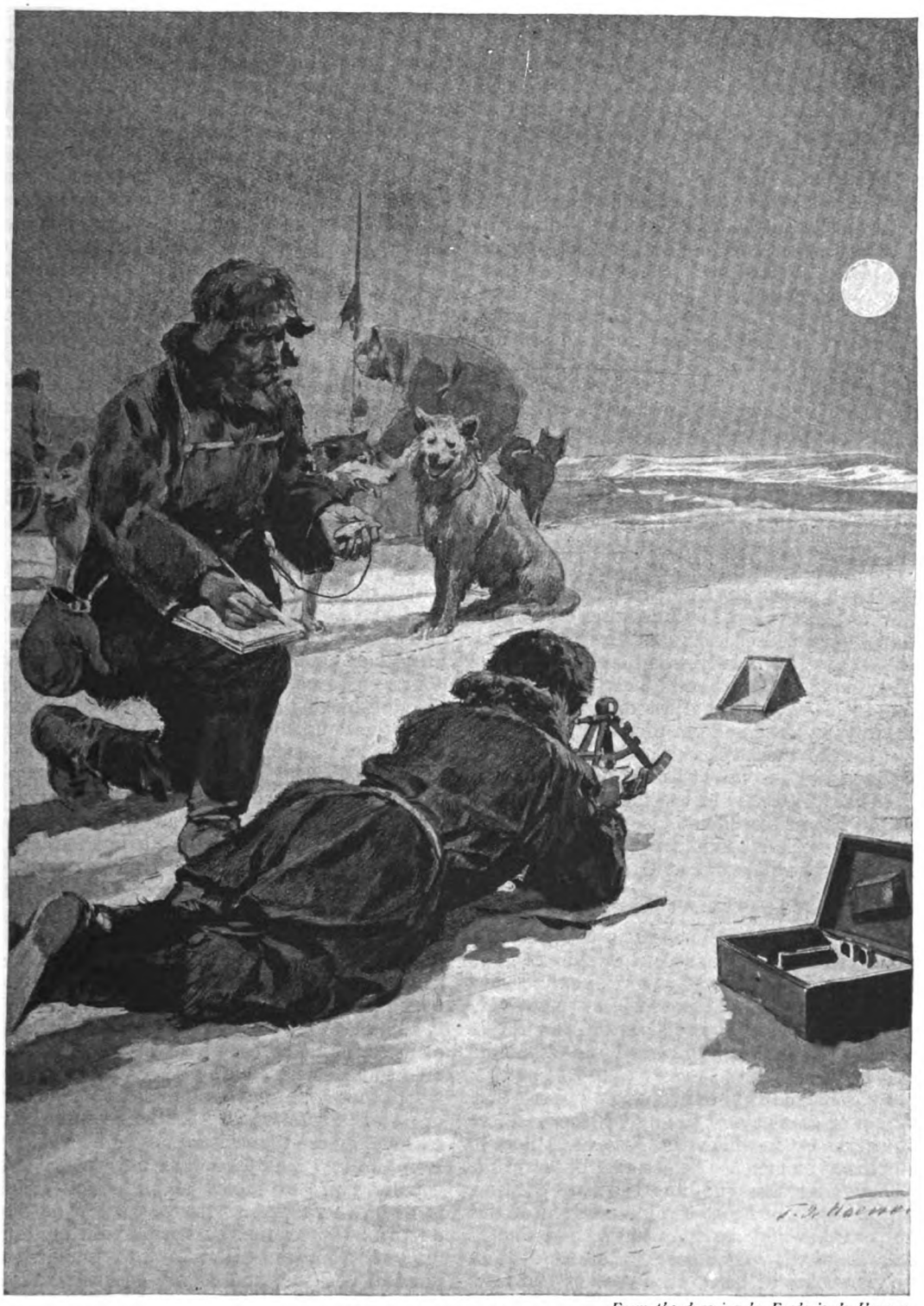
The time of the ship is found from the sun either early in the morning, or late in the afternoon, when the sun is as nearly as may be due east or due west. The observation takes a slightly different form. It is no longer a question of finding the maximum altitude, but the altitude corresponding to a given moment on the chronometer. By a calculation which is simple, but not by any means so simple as that above, the navigating officer deduces from the sun the local time of the ship, corresponding to the time shown on the chronometer. If the chronometer were really keeping precise Greenwich time, the difference between the time at the ship and the time at Greenwich would be simply the longitude of the ship.

Unhappily, the chronometer does not keep precise Greenwich time. Before the voyage begins it will have been rated by comparison with Greenwich time signals, or by the time balls, and thus it will start with a known error and a known rate. But the changes of temperature during the voyage and the motion of the ship must have some influence on the going of the chronometer, accurately compensated though it may be, and after a few weeks at sea he would be a fortunate navigator who could rely upon the mean of his chronometers—probably not more than three—giving him the correct Greenwich time within four seconds of time, or a mile of longitude on the Equator. Therefore it is highly desirable that he shall have some opportunity of finding Greenwich time by direct observation, or having it sent to him as a check upon the time which he has brought with him.

Longitude at Sea

In the old days he was compelled to practise an elaborate method known as the method of lunar distances, which was long and difficult, and extremely disliked by all except real enthusiasts. Nowadays the vibration of fast steamships makes it practically impossible to obtain sights of the necessary refinement; nor among the multitudinous duties of the navigator of a fast ship at sea is it possible to find time for the rather long and involved calculations. Happily, the need has disappeared through the shortening of voyages, the multiplication of time signals, and especially the introduction of the service of time by wireless. To-day a navigator must be in very unfrequented waters if he is not within range, at some time within the course of a few days, either with a wireless station on shore or a ship within wireless reach.

Another observation which is at least as necessary as the determination of position is the determination of the error of the compass. The compass-maker has learned how to shield the ship's compass from the more serious effects of the magnetisation of the



From the drawing by Frederic de Haenen.

LOCATING THE POLE.

Captain Amundsen, the intrepid Norwegian explorer, who reached the South Pole in December, 1911, a few weeks in advance of his unlucky rival, Captain Scott, making sure—by means of a sextant—that he has found his goal.

ship's steel structure; but it has not been done without loss of power in the compass needle. Hence it is, above all, important to have a means of checking the variations of the compass from day to day and from hour to hour.

This is done by the use of a device invented by Lord Kelvin, the azimuth mirror, of which it is enough to say here that it makes it possible to read within a fraction of a degree the observed compass bearing of the sun at a given moment. Knowing the position of the ship, and the local time at the ship, one can then calculate very quickly the true bearing of the sun at the instant of observation, and by comparison of the true with the observed determine the error of the compass.

All that we have said of the sun applies to the stars also, and with the continual improvement in the training of navigators that goes on year by year, there is a steady extension in the practice of star navigation. It happens often enough that the sun has been clouded all day, but clears at sunset. For an hour or so before it is quite dark the horizon will be beautifully clear and sharp, and the planets and brighter stars can be seen, especially when one knows just where to look for them. This is the occasion to make good the lost opportunities of the day, by finding from a couple of stars—one on the meridian and one east or west—the simultaneous latitude and longitude of the ship. Later in the night it will very likely be impossible to see the horizon, unless there is a moon; but a similar good opportunity will occur at dawn.

The New Navigation

Such in its simplest form is the problem of determining the place of a ship at sea. Of late years a more general method has been introduced and extensively practised, the method of what is called the New Navigation, which has superseded all others in the Navy.

Its great merit is that a single observation of sun or star at any time gives the position of a line upon which the ship finds herself at that moment. A second observation will give another line, and the true position of the ship will be at the intersection of the two. Or it may be that the second line is not required. The bearing of a distant known point of land, or a cast of the lead which shows that the ship is on a certain line of soundings, may, combined with a single sight, give an accurate "fix."

Now we can turn with profit to the case of the surveyor upon shore. If he is a traveller making a long journey to an unknown country, his methods will be very much like those of a navigator at sea, except that he will, if he is wise, carry ever so small a theodolite instead of the sextant with its clumsy "artificial horizon," such as must be used to supply the place of the convenient sea horizon the sailor has at his disposal.

If, on the other hand, he is a surveyor aiming at mapping an area of country, he will be to a certain extent independent of the sun and stars, and will work with his base line and theodolite triangulation—until he comes to consider the important question, whereabouts in the world is this territory of which he has produced so precise a picture. To answer that question, to pin the map down to the world in its proper position, he must know the latitude and longitude of one point, and the true direction of one side of his triangle. This he cannot determine except by astronomical methods.

Local Attraction

We have been careful to say that he observes *one* latitude and longitude. The question may very naturally be asked: Why does not he determine *all* his principal points astronomically, and leave to his theodolite and plane-table merely the filling-in of the detail between these points? The answer is that he cannot by astronomical methods determine the relative position of two points so accurately as he can by the method of base measurement and triangulation. What is more, he is always liable to get into trouble owing to local attraction, of which we shall speak more fully in the chapter on the size and shape of the earth.

Even in countries where the visible mountains are not at all conspicuous, the effects of local attraction may be great. At Edinburgh, where there are some hills visible, it amounts to more than five seconds of arc, or more than 500 feet—a discordance intolerable to the careful map-maker. In Moscow, where the mountains are far away, the effect of local attraction is, for some unknown reason, more than twice as great as at Edinburgh. And these are but rather unusually large examples of an effect which is everywhere present to a greater or less degree. Hence the surveyor will content himself, as a general rule, with one astronomical position, and so will ensure that his map does not contain any violent distortions from place to place, even though its precise location on the globe may very well be an error by a few seconds of arc, owing to local attraction.

A. R. H.

Continued from page 167

LANGUAGES:

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LATIN.—IV

The Fourth Declension

The Fourth or U-Declension contains two classes of nouns :—

Masculine nouns ending in **-us**.

1. Grădŭs (m.), *step ; base*, **grăd-**.
2. Neuter nouns ending in **-u**.

Gĕnū (n.) *knee ; base*, **gen-**.

	Sing.	*Plur.*	*Sing.*	*Plur.*
N.V.	grăd-**ŭs.**	grăd-**ūs.**	gen-**ū.**	gen-**ŭa.**
Acc.	grăd-**ŭm.**	grăd-**ūs.**	gen-**ū.**	gen-**ŭa.**
Gen.	grăd-**ūs.**	grăd-**ŭum.**	gen-**ūs.**	gen-**ŭum.**
Dat.	grăd-**ŭi.**	grăd-**ĭbŭs.**	gen-**ū.**	gen-**ĭbŭs.**
Abl.	grăd-**ū.**	grăd-**ĭbŭs.**	gen-**ū.**	gen-**ĭbŭs.**

There are six nouns, **acus**, *needle*, **arcus**, *bow*, **artus**, *limb*, **lacus**, *lake*, **tribus**, *tribe*, and **veru**, *spit*, of which the dative and ablative plural end in **-ubus**. There are a few other exceptions to the normal forms. Thus the dative case sometimes ends in **-u** in masculine nouns, **metus** (m.), *fear*, sometimes having the dative **metu.** There is occasionally a borrowing of forms from the second declension and vice versa. For example, **senati** and **tumulti** sometimes occur as genitives instead of **senatūs** and **tumultūs**; and the following nouns, **cŭpressus**, *cypress*, **fīcŭs**, *fig-tree*, **laurŭs**, *bay-tree*, and **pīnŭs**, *pine*, which in other respects follow the second declension, have gen. sing. in the form **laurī** or **laurūs**, abl. sing. **laurō** or **laurū**, and nom. plur. **laurī** or **laurūs.**

Dŏmŭs, *house*, is thus declined :—

	Sing.	*Plur.*
Nom.	dŏmŭs.	dŏmūs.
Acc.	dŏmum	dŏmōs or domūs.
Gen.	dŏmūs or dŏmī.	dŏmōrum or dŏmŭum.
Dat.	dŏmūī or dŏmō.	dŏmĭbŭs.
Abl.	dŏmō or dŏmū.	dŏmĭbŭs.

The locative of domus is **domī**, *at home.*

The Fifth Declension

In the Fifth or E-Declension the nominative singular is always formed by the addition of **-es** to the stem, as follows :—

Dĭēs (m. or f. in sing., m. in pl.), *day ; base*, **dĭ-**. Fĭdēs (f.), *faith ; base*, **fĭd-**.

	Sing.	*Plur.*	*Sing.*
N.V.	di-**ēs.**	di-**ēs.**	fĭdēs.
Acc.	di-**em.**	di-**ēs.**	fĭdem.
Gen.	di-**ēi** or diē.	di-**ērum.**	fĭdēī or fĭdē.
Dat.	di-**ēi** or diē.	di-**ēbŭs.**	fĭdēī or fĭdē.
Abl.	di-**ē.**	di-**ēbŭs.**	fĭdē.

Diēs is masculine when it means a particular day, but feminine when it signifies a period of time. With this exception and that of **mĕrĭdĭes**, *noon*, the nouns of this declension are feminine. There are no adjectives following either the fourth or the fifth declension.

The word **respublĭcă**, *common weal, commonwealth*, or *republic*, a composite word, is declined as follows :—

	Sing.	*Plur.*
N.V.	respublĭcă.	rēspublĭcae.
Acc.	rempublĭcam.	rēspublĭcas.
Gen.	rēīpublĭcae.	rērumpublĭcārum.
Dat.	rēīpublĭcae.	rēbuspublĭcīs.
Abl.	rēpublĭcā.	rēbuspublĭcīs.

The Declension of Adjectives

Some exceptional forms must be noticed in the declension of adjectives before we proceed to the comparison of adjectives.

The following have their gen. sing. in **-īus** or **-ĭus** :—

1. Alĭŭs, ălĭă, ălĭŭd, *another.*

	Sing.		
	Masc.	*Fem.*	*Neut.*
Nom.	ali-**ŭs**	ali-**ă**	ali-**ŭd.**
Acc.	ali-**um**	ali-**am**	ali-**ŭd.**
Gen.	alī-**us**	alī-**us**	alī-**us.**
Dat.	ali-**ī**	ali-**ī**	ali-**ī.**
Abl.	ali-**ō**	ali-**ā**	ali-**ō.**
		Plur.	
Nom.	ali-**ī**	ali-**ae**	ali-**ă.**
Acc.	ali-**ōs**	ali-**ās**	ali-**ă.**
Gen.	ali-**ōrum**	ali-**ărum**	ali-**ōrum.**
Dat.	ali-**īs**	ali-**īs**	ali-**īs.**
Abl.	ali-**īs**	ali-**īs**	ali-**īs.**

2. Altĕr, alterā, alterum, *one of two.*

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	altĕr	alter-**ă**	alter-**um.**
Acc.	alter-**um**	alter-**am**	alter-**um.**
Gen.	alter-**ius**	alter-**ius**	alter-**ius.**
Dat.	alter-**ī**	alter-**ī**	alter-**ī.**
Abl.	alter-**ō**	alter-**ā**	alter-**ō.**
		Plur.	
Nom.	alter-**ī**	alter-**ae**	alter-**ă.**

Etc., like the plural of **alĭus.**

Like **alius** (except in the nom. and acc. neut. sing.) are declined **nullŭs**, **nullă**, **nullum**, *no, none;* **sōlŭs**, **sōlă**, **sōlum**, *alone;* **totŭs**, **totă**, **totum**, *whole;* **ullŭs**, **ullă**, **ullum**, *any* (used after a negative); **ūnŭs**, **ūnă**, **ūnum**, *one;* and like **alter**, are declined **neutĕr**, **neutră**, **neutrum**, *neither;* and **ŭtĕr**, **ŭtră**, **ŭtrum**. The gen. sing. **alĭus** seldom occurs, **altĕrĭŭs** being ordinarily used instead.

The following compounds of **uter** are found: **ŭterquĕ**, **utraquĕ**, **ŭtrumquĕ**, *each* (of the two); **ŭtercumquĕ**, **ŭtrăcumquĕ**, **ŭtrumcunquĕ**, *whichever* (of the two); **ŭterlibet**, **ŭtrălĭbĕt**, **ŭtrumlĭbĕt**, *which* (of the two) *you please;* **ŭtervīs**, **ŭtrăvīs**, **utrumvīs** *which* (of the two) *you will.*

The Comparison of Adjectives

Latin adjectives, like English, have three degrees of comparison: the positive, which simply asserts the quality or nature of a thing; the comparative, corresponding to the word "more"; and the superlative, corresponding to "most." As in English these degrees are usually expressed by means of suffixes, **-ior** answering to *-er*, and **-issimus** to *-est;* but in a few rare cases **magis**, *more*, and **maxime**, *most*, are employed instead.

The meaning of the comparative and superlative inflections is wider in Latin than in English. Thus **durior** may mean *harder, rather hard*, or *too hard*, and **durissimus**, *hardest* or *very* or *intensely hard.* The comparative is declined like **mel or** (p. 164) and the superlative like **bonus** (p. 99).

The comparative is formed in the nom. sing. masculine by the addition of **-ior** to the base of the positive; the superlative, by the addition of **-issimus** to this base, as follows:—

Positive.	*Comparative.*	*Superlative.*
dūrus, *hard*	dur-**ior**	dur-**issimus.**
laetus, *glad*	laet-**ior**	laet-**issimus.**
lĕvis, *light*	lev-**ior**	lev-**issimus.**
tristis, *sad*	trist-**ior**	trist-**issimus.**
fēlix, *happy*	felic-**ior**	felic-**issimus.**
dīves, *rich*	divit-**ior**	divit-**issimus.**
ūtilis, *useful*	**util-ior**	**util-issimus.**

Some adjectives form their superlatives according to a slightly different rule.

(1) In adjectives ending in **-er** the final **r** of the nom. sing. is doubled and the suffix **-imus** is added, thus:—

Positive.	*Comparative.*	*Superlative.*
pulcher, *beautiful*	pulchr-**ior**	pulcher-**rimus.**
lĭber, *free.*	liber-**ior**	liber-**rimus.**
nĭger, *black*	nigr-**ior**	niger-**rimus.**

Vĕtŭs, *ancient*, forms its superlative thus, **vĕterrĭmŭs.**

(2) Some adjectives terminating in **-lis** form their superlative by doubling the **l** of the nom. sing. and adding **-imus**, thus:—

Positive.	*Comparative.*	*Superlative.*
făcĭlis, *easy*	facil-**ior**	facil-**limus.**
grăcĭlis, *graceful*	gracil-**ior**	gracil-**limus.**
sĭmĭlis, *like*	simil-**ior**	simil-**limus.**

After the same model are declined **difficilis**, **dissimilis**, and **humilis.**

(3) Adjectives ending in **-dĭcŭs**, **-ĭcŭs**, or **-vŏlŭs** add **-entĭor** and **entissĭmŭs** to the base to form the comparative and superlative. In this case the suffixes are added to a base corresponding to the participles of certain verbs, **-dīcens** (base **dīcent**) from **dīco**, *I say*, **-fĭcens** (base **fĭcent**) from **făcĭō**, *I make*, and **-vŏlens** (base **vŏlent**) from **vŏlō**, *I will.*

Positive.	*Comparative.*
bĕnĕfĭcus, *kindly*	beneficent-**ior.**
magnĭfĭcus, *magnificent*	magnificent-**ior.**
mălĕdĭcus, *evil-speaking*	maledicent-**ior**
mălĕvŏlus, *ill-wishing*	malevolent-**ior.**
bĕnĕvŏlus, *benevolent*	benevolent-**ior.**
ĕgēnus, *in want*	egent-**ior.**
prōvĭdus, *foreseeing*	provident-**ior.**

The superlative is beneficent-**issimus,** magnificent-**issimus,** etc.

VOCABULARY

cŭpīdo, -ĭnis (m. or f.), *desire, wish.*
ĕtĭam, *also, furthermore.*
expectātio, -ōnis (f.), *expectation.*
făcĭes, -ēi (f.), *face, countenance.*
fructus, -ūs (m.), *fruit.*
hostis, -is (c.), *enemy.*
ignōtus, -a, -um, *unknown.*
jūcundus, -a, -um, *delightful.*
lentus, -a, -um, *slow.*
luctus, -ūs (m.), *grief.*
mănet, *he, she,* or *it remains.*
mănent, *they remain.*
mănus, -ūs (f.), *hand.*
mātūrus, -a, -um, *ripe.*
omnis, -e, *all.*
praedĭtus, -a, -um, *endowed* (with).
pŭĕrĭlis, -e, *boyish.*
pulcher, -ra, -rum, *beautiful.*
quam, *than.*
quercus, -ūs (f.), *oak.*
rēs adversae (f., pl.), *misfortune.*
sĕd, *but, yet.*
spes, -ēi (f.), *hope.*
supplex, -ĭcis, *suppliant.*
tămen, *nevertheless, however.*
tendit, *he, she,* or *it stretched.*
suspectus, -a, -um, *suspected.*
vĭdet, *he, she,* or *it sees.*
vidētur, *he, she,* or *it seems.*
virtus, -ūtis (f.), *virtue.*

Exercise 4

Translate into English :—

1. Peregrini domi in urbe manent. 2. Cupido gloriae immortalis vires fortes ad arma vocat. 3. Spes expectatio boni est, metus est expectatio mali. 4. Lentis gradibus regina ad templum venit. 5. Non est amor tuus mihi ignotus, sed tamen gratus et jucundus. 6. Regibus boni quam mali suspectiores sunt. 7. In manibus nostris nulli hostes manent. 8. Manus supplices dis immortalibus tendit. 9. Fructus maturi et gratissimi in horto copia est. 10. Animo meo etiam in rebus adversis spes venit.

Translate into Latin :—

1. The mind of our king is endowed with all the virtues. 2. The face of our friend seems to me boyish, but beautiful and pleasing. 3. Rome the most beautiful of all cities. 4. All animals are endowed with senses. 5. Hope always remains in the minds of men. 6. The republic gives us many rewards of virtue. 7. The descent to Avernus is easy. 8. Happiness is the fruit of virtue. 9. He stretches suppliant hands to the judges. 10. Misfortune often calls men to virtue.

Key to Exercise 2

1. There are many doves in the island. 2. The poet has no friends. 3. The queen often comes into the city. 4. The slave came to his master in time. 5. The husbandman has ten slaves. 6. Caesar calls the people to arms. 7. They call an unknown man their lord. 8. Many foreigners come into Italy. 9. My friend gives rewards to the good boys. 10. The husbandmen have fertile lands.

1. Multi peregrini sunt in oppido. 2. Amicus meus in terram ignotam venit. 3. Filiae agricolarum pulchrae sunt. 4. In insula sunt magnae silvae. 5. dominus peregrinos in oppido vocat. 6. Amicus meus puellam pulchram vocat. 7. Regina nautis magna praemia dat. 8. Est mihi copia rosarum. 9. Est tibi hortus fecundus. 10. Arma peregrinorum infesta sunt nautis.

E. A. B.

FRENCH.—IV

Adjectives. — There are six kinds of adjectives—(1) Qualifying adjectives, as **la bonne mère,** *the good mother*. (2) Numeral adjectives, as **quatre chiens,** *four dogs*. (3) Demonstrative adjectives, as **ce soldat,** *this soldier*, **cette femme,** *this woman*. (4) Possessive adjectives, as **votre chapeau,** *your hat*. (5) Indefinite adjectives, as in **chaque homme qui vient,** *each man that comes*. (6) Interrogative adjectives, as in **quelle serviette avez-vous?** *what serviette have you?*

With the exception of many cardinal numbers, all adjectives are modified in form to express gender and number, in which the adjective agrees with the substantive that it qualifies.

The general rule is that the feminine may be formed from the masculine of adjectives (not already ending in **e** mute) by the addition of **e** mute ; thus—

un garçon diligent, *a diligent boy.*
une fille diligente, *a diligent girl.*

The exceptions to this rule are as follows :—

(1) Adjectives ending in **el, eil, en, on, as, os,** double the last consonant and add **e** mute in the feminine ; thus—

essentiel, essentielle, *essential.* bon, bonne, *good.*
vermeil, vermeille, *vermilion.* bas, basse, *low.*
ancien, ancienne, *ancient.* gros, grosse, *stout.*

(2) Adjectives ending in **et** usually form their feminine in this way, as—

sujet, sujette, *subject.*

But the following take the grave accent on the **e** instead of doubling the last consonant :—

complet, complète, *complete;* concret, concrète, *concrete;* discret, discrète, *discreet;* inquiet, inquiète, *uneasy;* replet, replète, *replete;* secret, secrète, *secret.*

(3) Adjectives ending in **f** change this into **ve,** those ending in **x** change this letter into **se**, as—

neuf, neuve, *new;* heureux, heureuse, *happy.*

The **s** in the feminine is doubled in some adjectives ending in **x** in the masculine, as—

faux, fausse, *false.* roux, rousse, *reddish.*

Doux, *sweet*, has **douce** in the feminine.

(4) Adjectives ending in **er** take the grave accent on the last **e**, and add **e** mute, thus—

leger, legère, *light.* étranger, étrangère, *foreign.*

(5) The adjectives **beau,** *handsome*, **fou,** *foolish*, **jumeau,** *twin*, **mou,** *soft*, **nouveau,** *new*, **vieux,** *old*. form their feminine in **lle,** thus—**belle, folle, jumelle, molle, nouvelle, vieille.** The old form of these adjectives ending in **el,** from which the feminine was formed in the same way as **essentielle** from **essentiel,** or **vermeille** from **vermeil,** persists in the masculine form used before a vowel or **h** mute.

Examples :—

un bel encrier, *a handsome inkstand.*
un bel habit, *a handsome coat.*
le nouvel an, *the new year.*
un vieil ami, *an old friend.*

(6) Adjectives ending in **eur** usually form the feminine by changing this to **euse,** as—

voleur, voleuse, *thievish.* menteur, menteuse, *lying.*

Others follow the general rule, as—

meilleur, meilleure, *better.* inférieur, inférieure.

(7) Some adjectives ending in **c** change this to **que** in the feminine, as—

public, publique, *public.* turc, turque, *Turkish.*

The feminine of **grec,** *Greek*, is **grecque.** Others ending in **c** change to **che**—

blanc, blanche, *white.* franc, franche, *frank.*

(8) The following should be memorised :—

accusateur,	accusatrice,	*accusing.*
bénin,	bénigne,	*benignant.*
coi,	coite,	*quiet.*
favori,	favorite,	*favourite.*
frais,	fraîche,	*fresh.*
gentil,	gentille,	*pretty.*
long,	longue,	*long.*
malin,	maligne,	*malignant.*
nul,	nulle,	*no.*
sec,	sèche,	*dry.*
tiers,	tierce,	*third.*
vengeur,	vengeresse,	*avenging.*

A few other adjectives, e.g. **débiteur,** *owing,* **protecteur,** *protecting,* form their feminines like **accusatrice,** and **enchanteur,** *enchanting,* like **vengeresse.**

Gender of Nouns

These rules apply to the formation of the feminine of nouns, except that **e** mute is changed to **esse.** The following are miscellaneous examples :—

cousin, *cousin.*	cousine.
prince, *prince.*	princesse, *princess.*
baron, *baron.*	baronne, *baroness.*
chien, *dog.*	chienne, *bitch.*
époux, *husband.*	épouse, *wife.*
pécheur, *sinner.*	pécheresse.
ambassadeur, *ambassador.*	ambassadrice.
berger, *shepherd.*	bergère, *shepherdess.*
ouvrier, *workman.*	ouvrière, *workwoman.*
orphelin, *orphan.*	orpheline.
hôte, *host.*	hôtesse, *hostesse.*
paysan, *peasant.*	paysanne.
pêcheur, *fisherman.*	pêcheuse, *fisherwoman.*
acteur, *actor.*	actrice, *actress.*
écolier, *schoolboy.*	écolière, *schoolgirl.*

In many cases the feminine is a different word from the masculine.

bouc, *he-goat.*	chèvre, *she-goat.*
cerf, *stag.*	biche, *hind.*
coq, *cock.*	poule, *hen.*
gendre, *son-in-law.*	bru, *daughter-in-law.*
neveu, *nephew.*	nièce, *niece.*

The following are irregular in the formation of the feminine :—

abbé, *abbot.*	abbesse, *abbess.*
chat, *tom-cat.*	chatte, *she-cat.*
compagnon, *companion.*	compagne.
dieu, *god.*	déesse, *goddess.*
duc, *duke.*	duchesse, *duchess.*
empereur, *emperor.*	impératrice, *empress.*
gouverneur, *governor*	gouvernante.
héros, *hero.*	héroïne, *heroine.*
mulet, *mule.*	mule.
serviteur, *servant.*	servante.

Plurals.—Adjectives form their plurals in the same way as nouns (*see* Lesson III.).

Exceptions—a few adjectives ending in **al** do not change into **aux** in the plural, e.g. **fatal, fatals,** *fatal ;* **naval, navals,** *naval.*

VOCABULARY

avec, *with.*	la plume, *the pen, the feather.*
bien, *very, well.*	la porcelaine, *porcelain.*
la cité, *the city.*	puissant, *powerful.*
content, *pleased.*	que, *than.*
la coutume, *the custom.*	son, sa, ses, *his, her, its*
fait, *done.*	le soulier, *the shoe.*
la forteresse, *the fortress.*	tout, *all, whole.*
grand, *large, big.*	tout à fait, *altogether.*
la maison, *the house.*	très, *very.*
le matin, *the morning.*	la ville, *the town, city.*
mauvais, *bad.*	vif, *lively.*
obligeant, *obliging.*	voici, *here.*
l'oiseau (m.), *the bird.*	voilà, *there.*
paresseux, *lazy.*	
pauvre, *poor.*	

Exercise 5

1. Le pauvre enfant a une bonne mère. 2. Cet homme est un bon père pour ses enfants. 3. J'ai vu plusieurs soldats. 4. C'est un grand malheur. 5. Mon fils est un joli garçon. 6. Tous les écoliers sont très aimables. 7. Votre tailleur est bien obligeant. 8. Voilà la gouvernante de mes enfants. 9. Nous sommes une famille très heureuse. 10. Toute la ville est très inquiète. 11. Ce garçon et cette jolie fille sont des jumeaux. 12. J'ai un vieux père et une marraine qui n'est pas très vieille. 13. Ce bel habit est fait de drap de laine. 14. J'ai une belle robe de soie. 15. Le coq est un oiseau blanc, mais la poule est noire. 16. Cette cité turque est une forteresse puissante. 17. Je suis tout à fait franc avec vous, soyez franche avec moi. 18. L'air du matin est assez frais. 19. Les feuilles ne sont pas jeunes et fraîches, mais plutôt vieilles et sèches. 20. Ma bru est une bonne ouvrière.

Exercise 6

1. Have you a diligent boy and a diligent girl ? 2. My boy is diligent, but my daughter is idle. 3. Is this custom ancient ? 4. This custom is not ancient, it is new. 5. Is your pen good or bad ? 6. My sister is very lively. 7. Is your daughter pleased ? 8. Is your cousin happy ? 9. Yes, she is good, beautiful, and happy. 10. Has your sister a new dress and new shoes ? 11. I have old shoes and an old dress. 12. No, I am neither sleepy nor hungry. 13. Has not your brother a handsome coat ? 14. Have you good meat, sir ? 15. I have excellent meat. 16. Has your friend a handsome inkstand ? 17. His inkstand is handsome, but it is not china. 18. Is any one hungry ? 19. No one is hungry. 20. Are the generals here ?

Key to Exercise 3

1. You have not a silk dress. 2. Has he never had a gold watch ? 3. Have you not seen him ? 4. I have not seen him. 5. Is anything the matter with him ? Nothing is the matter with him. 6. Have you met any one ? No one. 7. I shall not be here any longer. 8. You will scarcely have time for that. 9. We shall have neither roof nor country. 10. We have no game. 11. Has she no hat ? 12. Has the merchant no money ? 13. Are you sleepy ? Not at all. 14. You are wrong. 15. Are you not cold ? No. 16. They are right. 17. The tailor has the curé's cloth coat. 18. The father has meat, you have coffee, and I have water. 19. The man has the bread, the child has the salt, and we the pepper. 20. Has your brother a pound of butter ? E. A. B.

GERMAN.—I

In many ways the German language is very closely related to English. The two languages are, so to speak, cousins, being both descendants of one and the same dialect.

It will greatly help the student if he makes a careful note of all German words that resemble English ones, as he comes across them. As regards the consonants, there are certain changes from the English forms that occur fairly regularly in German. For instance, where in English we find *d* in German we find t, for English *p* we have German f or pf, and English *k* is represented in German by ch. (*See* Fig. below.)

Take, by way of illustration, the following examples :—

English	*German*		*English*	*German*
ten	zehn	..	water	Wasser
that	das	..	foot	Fuss
deep	tief	..	pan	Pfanne

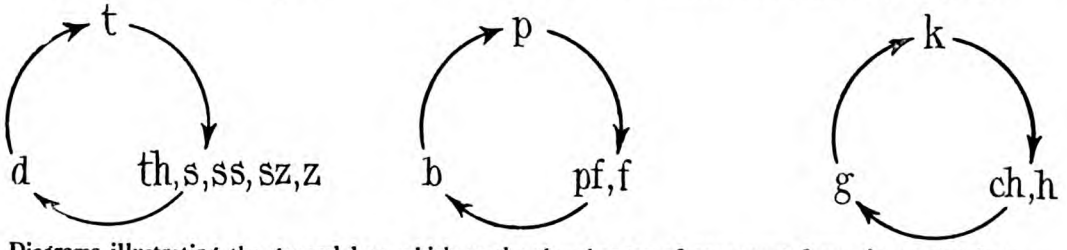
Pronunciation.—In pronouncing German the student must be very careful to give each sound its full value.

Vowels.—In German, as in English, vowels are either long or short. We may illustrate with a few English examples—

Words with long vowel	*Words with short vowel*
father	hat
deep	dip

As a general rule, German vowels are long, unless they are followed by two or more consonants, in which case they are short; but if the first letter of the group of consonants is h, then the preceding vowel is always long.

In addition to the vowels a, e, i, o, u, there are the diphthongs ai, au, ei, eu. Further, the vowels a, o, u are capable of being modified; this modification is indicated by two dots over the vowel, thus : ä, ö, ü, äu.



Diagrams illustrating the general law which marks the changes of consonant forms in passing from English into German; English *d* becomes German *t*, and English *t* becomes German *th, s, ss,* etc.

ALPHABET

Gothic type	*Written character*	*Roman type*	*Name*
𝔄 𝔞		A a	ah
𝔅 𝔟		B b	bay
𝔠		C c	tsay
𝔇 𝔡		D d	day
𝔈 𝔢		E e	ay
𝔉 𝔣		F f	eff
𝔊 𝔤		G g	gay
𝔥		H h	hah
𝔦		I i	ee
𝔍 𝔧		J j	yott
𝔎 𝔨		K k	kah
𝔩		L l	ell
𝔐 𝔪		M m	emm
𝔑 𝔫		N n	enn
𝔒 𝔬		O o	oh
𝔓 𝔭		P p	pay
𝔔 𝔮		Q q	koo
𝔯		R r	ayrr
𝔖 𝔰 ſ		S s	ess
𝔗 𝔱		T t	tay
𝔘 𝔲		U u	ooh
𝔙 𝔳		V v	fow
𝔚 𝔴		W w	vay
𝔛 𝔵		X x	ix
𝔜 𝔶		Y y	ipsilon
𝔷		Z z	tset

Vowel	*Sound*	*Symbol by which pronunciation will be indicated*
a, aa *long* a	*as in* **f**a**th**er	ah
a *short* a	*the above sound shortened*	a
ä *long* ä	*as in* d**ay**	ä, ay
ä *short* ä	*as in* b**e**t	e
e, ee *long* e	*as in* d**ay**, *but narrower*	ay
e *short* e	*as in* b**e**t	e
e *unaccented* e	*as in* op**e**n	ə
i, ie *long* i	*as in* b**ee**n	ee
i *short* i	*as in* b**i**t	i
o, oo *long* o	*as in* b**o**ne	oh
o *short* o	*as in* h**o**t	o
ö *long* ö		ö
ö *short* ö		*o* (italic)
u *long* u	*as in* b**oo**t	oo
u *short* u	*as in* b**oo**k	u
ü *long* ü		ü
ü *short* ü		*u* (italic)
ai, ei	*as in* n**i**ne, wh**y**	y
au	*as in* n**ow**	ow
äu, eu	*as in* b**oy**	oy

(NOTE.—Diphthongs are always long.)

The pronunciation of long e and of long ö and short ö and ü presents some difficulty to the English student; but if he will carefully follow the instructions given here he ought, with a little practice, to learn to pronounce them with ease.

Long e is, as we have said, like English ay in "d**ay**," only the sound is narrower. In order to obtain this narrow effect, raise the tongue, so that it is a little nearer the roof of the mouth than when pronouncing English ay.

Long ö is produced in the following way. Pronounce a long German e in the manner described above, then, while continuing to make this sound, round the lips as if you were going to whistle. The resulting vowel sound will be the one required.

Short ö is produced by first pronouncing ə (the e sound in English "open"), and then rounding the lips as indicated above.

Long ü is produced by first pronouncing a long ee, and then, while continuing to emit this sound, rounding the lips.

Short ü is produced by sounding a short i and then rounding the lips.

Consonants.—In German the consonants are pronounced as in English, with the following exceptions:—

c before e, i, y is pronounced ts, and in this case is often written z.

c before other vowels is pronounced k, and is then often written k, except in foreign names.

ch after the vowels a, o, u, au is pronounced like ch in Scotch "loch," and will be indicated by *k* (italic).

ch in other cases has a sound which we shall indicate by *ch* (italic), and which will be explained below.*

ck is pronounced k.

chs is pronounced ks.

g is like g in "**g**ame" or gu in "**gu**ess," and will be indicated by g; but after a vowel it is often pronounced like German ch, i.e. *k* or *ch*, as the case may be. (The pronunciation of g varies considerably in different parts of Germany.)

h is like English h, but is not sounded after a vowel.

j is like y in "**y**et," and will be indicated by *y* (italic).

ng between vowels is like English ng in "sin**g**er."

ng at the end of a syllable is like ngk.

qu is like kv.

s is like z or English s in "rose," when it occurs at the beginning of a syllable or between vowels.

s at the end of a word, or before a consonant, is like ss.

sch is like English sh.

sp, st at the beginning of a syllable are pronounced shp, sht respectively.

ß is like ss.

v is like f.

w is like v.

z is pronounced ts.

b and d at the end of a word are pronounced p and t respectively.

dt is pronounced t.

ti in words of French origin is pronounced ts*y*, thus the terminations tient and tion are pronounced ts*y*ent and ts*y*ohn.

tz is pronounced ts.

Spelling.—All nouns, whether common or proper, are written with a capital letter, as is the pronoun of address, Sie, in all its cases. (Note, ich = I is never written with a capital letter except at the beginning of a sentence.)

Long s (ſ) is used at the beginning of a syllable and in double s (ſſ) between vowels.

Short s (s) is used at the end of a syllable.

ſſ and ß, which have the same sound, are used in the following way: ss is used between the two vowels when the first vowel is short; in all other cases, i.e. at the end of a syllable and after a long vowel, sz is used.

Accent.—The accentuation of words in German is in principle the same as in English. That is to say, words are, as a general rule, accented on the stem or root syllable. Thus, in English we say wáter with the accent on the first syllable, which is the stem of the word; similarly, in German we say Wásser (vássər, with the accent on the first syllable.

The following rules may be noted —

The main accent never falls on terminations of declension or conjugation, hardly ever on suffixes of derivation, and never on prefixes, unless these are separable. (These will be dealt with later on.) Exceptions are the suffix "ei" and the "ie" of the termination ieren in verbs and ier in nouns. A few anomalous words will be noted as they occur.

In compound words the accent falls on the determinative component, that is, in compound nouns on the first word, similarly in compound verbs and adjectives, e.g. Schúlhaus (shoólhowss), school'house, téilnehmen

* The sound indicated by *ch* is produced in the front of the mouth by letting the breath escape between the palate, just behind the teeth, and the tongue, which has been raised so that the part of it just behind the tip almost touches the palate.

(tylnaymən), to take part, dánkbar (dánkbahr), thankful. In other compound words the accent falls on the second component, e.g. damít (dahmít), therewith.

Exceptions are many compounds of "all," such as allmä'chtig (almé*ch*tig), almighty, and other words which will be noted as they occur. The negative prefix "un" usually bears the main accent.

Parts of Speech.—We find in German the following parts of speech:

1. A Noun gives the name of a thing: **Strasze** (shtrahssə), *street;* **Baum** (bowm), *tree;* **Wilhelm** (vilhelm), *William.*
2. An Adjective describes a thing, or indicates some quality of it: **lange** (langə) Strasze, *long street;* **gutes** Kind (gootəs kint), *good child.*
3. A Pronoun is used instead of a noun: **sie** (zee), *they;* **der** (dayr), *who.*
4. A Verb makes a statement about some person or thing, or else it asks a question or issues a command: ich **spreche** (i*ch* shprec*h*ə), *I speak;* **kommen** sie? (kommən zee?), *do they come?*
5. An Adverb modifies some verb, adjective, or other adverb; **sehr** grosz (zayr grohss), *very big;* er geht **schnell** (ayr gayt shnell), *he walks quickly.*
6. A Preposition is used with a noun or pronoun to show its connection with, or relation to, other words in a sentence: wir sitzen **in** dem Zimmer (veer zitsən in daym tsimmər), *we sit in the room.*
7. A Conjunction links together either nouns and pronouns, or joins sentences to one another: der Mann **und** die Frau (dayr mann unt dee frow), *the man and the woman;* mein Vater **und** ich (myn fahtər unt i*ch*), *my father and I;* das Kind ging fort **ehe** wir kamen (dass kint gink fort ayhə veer kahmən), *the child went away before we came.*
8. An Interjection is a cry which expresses some emotion and is not an integral part of a sentence: **ach** (ah*k*), *ah,* **horch** (hor*ch*), *hark.*

(NOTE.—We include the so-called definite and indefinite articles—*the* and *a, an*—among the demonstrative adjectives.)

Inflexions.—The changes in form that words undergo to become parts of a sentence are called inflexions. If we take the words "John," "see," "he," we cannot make a sentence out of them until we have inflected them thus: "John sees him." In most words, the main part remains unchanged, and is inflected by the addition of some letter or syllable. The unchanged portion of the word is called the stem; the additional letters or syllables are called prefixes when placed before the stem, and suffixes or terminations when placed after it. (A large number of verbs and some nouns are also inflected by a change in the vowel of the stem, but these will be dealt with later on in their proper place.)

Examples:—Ich gebe (ich gaybə): **geb** is the stem and **e** is the suffix or termination; gegeben (gaygaybən): **geb** is the stem, **ge** is the prefix, and **en** the termination.

Number, Gender, Case.—Nouns and pronouns are inflected for number, gender, and case.

Number.—There are two numbers: the singular and the plural. The former is used in speaking of one person or thing, and the latter in speaking of two or more persons or things. Der Mann (dayr mann), *the man,* is singular; but die Männer (dee mennər), *the men,* is plural.

Gender.—There are three genders in German, as in English—masculine, feminine, and neuter; but whereas in English it is an easy matter to determine the gender of any noun, since all inanimate objects and animals (mostly) are neuter, in German it is by no means so simple. Later on we shall give the student some rules for the gender of nouns, but it is only fair to admit that there are many exceptions to any rules that one may formulate, and that the only safe guides are experience and the exercise of memory. The best plan is to learn each noun with the definite article (the) prefixed to it. Thus the student should not learn: Löffel, *spoon;* Gabel, *fork;* Messer, *knife;* but der Löffel, (dayr löffəl), die Gabel (dee gahbəl), das Messer (dass messər).

Case.—Cases are used to show the relation of nouns to other words in a sentence. There are four cases in German.

The Nominative is used for the subject of the sentence. This corresponds to the Nominative in English: **Der Mann** geht (dayr mann gayt), **the man** *walks.*

The Accusative is used for the direct object of the verb, and corresponds to the Objective in English: Sie sah **den Hund** (zee zah dayn hunt), *she saw* **the dog.**

The Genitive denotes possession, and corresponds to the Possessive in English. Der Hut **des Kindes** (der hoot dess kindəs), **the child's** hat.

The Dative is used for the indirect or remoter object, and is often translated by

putting the preposition "to" or "for" before the noun: Ich gab **dem Kinde** ein Buch (*ich* gahp daym kində yn boo*k*), *I gave* **the child** *a book*, or *I gave a book* **to the child.**

The student will notice that the definite article ("the") varies in form in German according to the gender, number, and case of the noun it qualifies.

Declension of the Definite Article

	Masculine	*Feminine*	*Neuter*
Nom.	der (dayr)	die (dee)	**das** (dass)
Gen.	des (dess)	der (dayr)	des (dess)
Dat.	dem (daym)	der (dayr)	dem (daym)
Acc.	den (dayn)	die (dee)	das (dass)

	Plural, all Genders
Nom.	die (dee)
Gen.	der (dayr)
Dat.	den (dayn)
Acc.	die (dee)

The above table should be thoroughly studied and committed to memory. The following points are worth noting, and will assist the student in remembering the various forms:—

1. In the feminine and neuter singular, and in the plural, the nominative form is the same as the accusative. Only in the masculine singular is there a difference between the two.
2. The genitive singular of the masculine and neuter are alike, and so are the dative singular masculine and neuter.
3. The genitive and dative singular of the feminine are the same.
4. The feminine singular and the plural forms are identical in all cases except the dative.
5. The dative plural is the same as the masculine accusative singular.

Personal Pronouns (Nominative Case).

	Singular	*Plural*
1	ich (ich), *I*	wir (veer), *we*
2.	Sie (zee), *you*	Sie (zee), *you*
3	er (ayr), *he* sie (zee), *she* es (ess), *it*	sie (zee), *they*

There is a familiar form of the second personal pronoun singular, du (doo), *thou*, and also of the second personal pronoun plural, **Ihr** (eer), *ye, you;* but the student need not trouble about them at present.

The Verb Sein (zyn), *to be.*

Present Indicative

ich bin (ich binn), *I am*	wir sind (zint), *we are*
er ist (ist), *he is*	Sie sind (zint), *you are*
sie ist (ist), *she is*	sie sind (zint), *they are*
es ist (ist), *it is*	

Preterite Indicative

ich war (vahr), *I was*	wir waren (vahrən), *we were*
er war (vahr), *he was*	Sie waren (vahrən), *you were*
sie war (vahr), *she was*	sie waren (vahrən), *they were*
es war (vahr), *it was*	

The Negative Adverb is **nicht** (nic*h*t).

Examples of negative and interrogative forms:—Ich bin nicht, *I am not.* Ist es? *Is it?* Sind wir nicht? *Are we not?*

When writing German the student need not trouble to use the German written character.

Exercise 1

1. Er iſt. 2. Sind wir? 3. Sie iſt nicht. 4. Bin ich? 5. Sie iſt nicht. 6. Iſt ſie? 7. Sind ſie nicht? 8. Sind Sie?

9. It is. 10. Are you? 11. We are not. 12. They are. 13. Is it not? 14. Were they? 15. I was not.

VOCABULARY

wo? (voh), *where?*
wann? (vann), *when?*
was? (vass), *what?*
oben (ohbən), *upstairs, above.*
ja (yah), *yes.*
heute (hoyte), *to-day.*
aus (owss), *out.*
aber (ahbər), *but.*
ſchon (shohn), *already.*
immer (immər), *always.*
zu Hause (tsoo howzə), *at home.*
die Frau (dee frow), *the woman.*
und (unt), *and.*
da (dah), dort (dort), *there.*
wer? (vayr), *who?*
hier (heer), *here.*
unten (untən), *downstairs, below.*
nein (nyn), *no.*
geſtern (geſtərn), *yesterday.*
auch (owk), *also.*
noch (nok), *yet, still.*
nie (nee), *never.*
der Mann (dayr mann), *the man.*
das Kind (dass kint), *the child.*

Unterhaltung (Conversation)

(Untərhaltungk)

Wo bin ich?
Wer iſt da?
Wer war geſtern hier?

Wann ſind Sie zu Hauſe?
Waren wir geſtern dort?
Sind ſie aus?

Wo iſt der Mann heute?
Wo iſt die Frau?
Was iſt das?
Waren ſie nie dort?

Wo iſt er?

Iſt ſie noch hier?
War es nicht oben?

Sie ſind hier.
Der Mann iſt hier.
Die Frau war hier, aber das Kind war nicht hier.

Ich bin heute zu Hauſe.
Ja, aber ich war nie dort.
Nein, er iſt oben und ſie iſt unten.

Er iſt zu Hauſe.
Sie iſt auch zu Hauſe.
Es iſt das Kind.
Ja, wir waren ſchon geſtern dort.

Er iſt nich immer zu Hauſe, er iſt heute aus.
Nein, ſie iſt nicht hier.
Nein, es war unten.

Exercise 2

1. Where are you? 2. I am upstairs. 3. Is she also there? 4. No; she is downstairs, but he is here. 5. Who is she? 6. Where were they? 7. The man was here, and the child was there. 8. Is it here? Yes. 9. Are you at home to-day? 10. No; and I was also out yesterday. 11. Is the woman still here? 12. No; she is never here. 13. Was the man at home? 14. No; he was already out. 15. We are always out.

M. A. L.

Continued from page 175.

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

DRAWING.—III

THE chief trouble at the outset of a lesson in Perspective is that you must learn a whole list of new expressions and phrases which belong exclusively to the matter in hand. And Perspective is impossible to understand or to put into practice without first learning the A B C.

Perspective—which means literally "a looking through"—is, to use an old definition, "the art of drawing objects on a flat surface as those objects actually appear to the eye."

If a young child tries to draw any object, you will generally find he makes certain ridiculous mistakes. For instance, he will draw a man's face in profile and yet put two eyes into it. Why is this? The child cannot *see* a face like that. The answer is simple enough. *He does not draw what he sees before him.* He draws what he knows is there.

In the same way, a child will draw a box or chest of drawers. Seat him down at one side of the object and tell him to copy it. The chances are a hundred to one that he will do nothing of the kind. He will draw more or less accurately, as the case may be, the box or chest from the view of it which he remembers, not the view that he sees. Consequently, the result will be something like the Fig. 14. Here you will see that *all* the front and *all* the side of the box are represented. So this drawing is absurd, because never at the same moment can all the two surfaces of the box be seen by the same pair of eyes.

A simple test is as follows: Take a piece of glass and look at your object—say a box—through it. Now be sure that you keep the glass still in exactly the same position, and then trace on it with a paint brush (a pencil will not mark well enough on glass) the precise outline that you see. You will, in this way, get an accurate drawing in perspective. But that is a parrot lesson. You do not in that case know what you are doing, or why you are doing it. You must learn your lesson properly. The first thing, therefore, is to master the technical terms applied to the art of perspective.

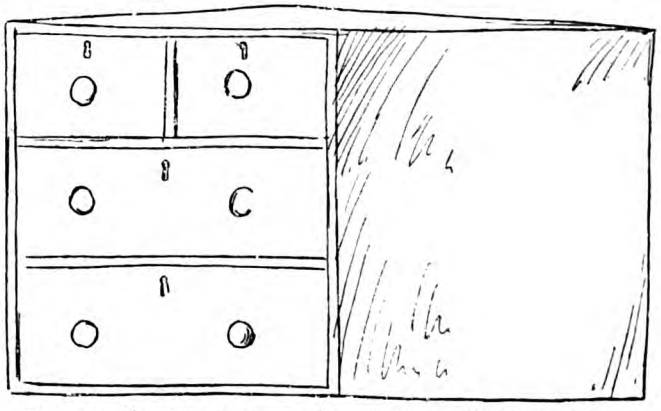


Fig. 14.—As drawn by a child. A chest of drawers drawn on a flat surface, but not as it appears to the eye: not in perspective.

Retiring lines is the first expression to tackle. These are those lines which run away from you into the distance, near or far as the case may be. Stand in a passage, and look down it. The lines of the doors, tops and bottoms of pictures and the furniture in that passage retire from you.

If you sit at one end of a table the lines of the two sides retire, while the top surface is called a retiring plane. Retiring planes, just like retiring lines, are sometimes horizontal, sometimes perpendicular, sometimes inclined. A horizontal plane is parallel with the earth; for example, the lid of a box, or the seat of a chair. Perpendicular planes are upright; for example, the wall of a house. An instance of an inclined plane is the roof of a house.

Take as your object a street. The road or pavement a horizontal plane, the fronts of the houses form a perpendicular plane, and they are retiring planes. Now add to your street a flight of steps leading up to a house. The fronts of the steps are parallel perpendicular retiring planes, their treads are horizontal retiring planes.

Having learned these simple instances and the rules which govern them, you should now turn to a further list of names, phrases or principles in perspective. These have been tabulated by the authority already quoted in the following manner:

6. *All retiring lines have vanishing points.*

7. *The vanishing points of all horizontal retiring lines are upon the line of sight.*

8. *All parallel retiring lines have the same vanishing point.*

9. All horizontal lines which are parallel with the picture plane are drawn parallel with each other and the line of sight.

10. All horizontal retiring lines forming right angles with the picture plane, or with your station, have their vanishing point at the point of sight.

11. All lines inclined with the horizon, and with the picture plane, have their vanishing points

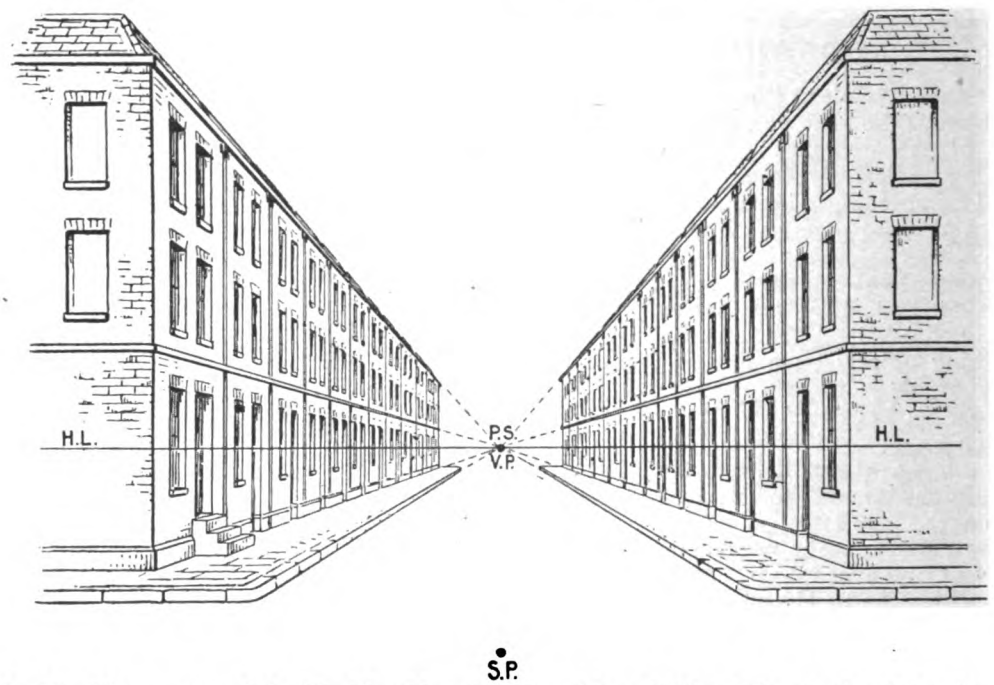


Fig. 15.—Diagram to explain "Retiring Lines." H.L. = Line of Sight; S.P. = Station Point, i.e. where the observer is standing; P.S. = Point of Sight, i.e. the point exactly opposite the eye; V.P. = Vanishing Point.

1. *The Line of Sight, or Horizontal Line,* marks the height of the eye in the picture. It is marked H.L. in Fig. 15—the drawing of the street.

2. *The Point of Sight.*—This is initialled P.S., and is the point exactly opposite the eye in the picture, and therefore it is on the line of sight. The line of sight is the level to which the eye naturally falls; the point of sight is the point where your glance naturally becomes concentrated.

3. *The Station Point* (S.P.) is the spot where you are reckoned to stand when you are looking at the object represented. An object necessarily varies according to the station point—and hence the point of sight varies with it.

4. *The Ground Plan* is the horizontal extent of the object when drawn upon the ground.

5. *The Vanishing Point* is that point on the surface or plane of the picture where retiring lines, if produced or continued, either meet or end altogether. This is marked V.P. in the diagram.

above or below the line of sight, according to the angle they form with the horizon; their vanishing points being always on a line perpendicular to the vanishing point upon the line of sight, to which they would have retired had they been horizontal.

Before going any farther it is necessary to give some amplification of the above rules.

The *Line of Sight* is drawn parallel with the base of the picture (or the outer edge of your drawing paper, provided that it is quite straightly cut), according to the height of the eye from the ground. If you are drawing an object—say a house or a group of buildings—from a higher point of view than where you are standing or are seated on the ground, the line of sight will be higher in the former than in the latter case.

The *Point of Sight* is decided as to its height from the ground (or from the base of the picture) by the line of sight.

The *Station Point* is at practically any distance

from the object that happens to be convenient. But you should never, when drawing from Nature particularly, come too close to your object. If you do you will get a distorted impression. This is very easily observed by a practical experiment. Stand up, keeping quite still and not moving your head. Then move your eyes only from right to left, looking at the objects about you. All that you can by any possibility see from that position is within sixty degrees. That is to say, you see very little. If you wish to see a larger number of objects or a more comprehensive view of one object, you must move your head this way and that. You then have more than one point of sight. This is certainly not allowable in art. Your station point should be at such a distance from the object that it comes within an angle of between 20° and 25°.

Take Fig. 16: *a* and *b* are two objects, both of which must be drawn in the same picture. Let us say that they are a chair and a table. The point *c* is about the nearest possible which includes them both, and then *b*, *c*, *a* make an angle of 60°. How much better if you move right away to *d*, where the angle is very much less, and where the two objects will appear closer together and more convenient for drawing. The expression "drawing from Nature" you should understand to mean not only drawings from flowers and trees, but houses and other things which are not natural.

The *Ground Plan* is best explained by saying that it is merely a plan in the usual sense of that word. The foundations of a house are its ground plan.

The *Vanishing Point* of a line is the spot where a line drawn from the eye parallel to any original straight line of an object cuts the surface of the picture.

Having grasped these explanations and principles, you should set to work and put them into practice by looking through a piece of glass as described above. You look through the glass at a piece of furniture or through a window at another house. Regard your glass as your picture plane. On it you trace the outline of the object with a brush and paint, and the place where you stand is your station point. The retiring side of the house you are looking at through the window is, say, on your left. Hold up your left arm parallel to the retiring plane of the house and you will then be pointing to the vanishing point of the retiring plane, which will be the left-hand side of the house in question. Then remember that all horizontal lines upon that plane will be retiring also, and that therefore they will all meet at the same vanishing point.

For the sake of practice make a tracing on the glass of a few of the retiring lines of the house, and mark the vanishing point on the wall. If you then produced (that is to say, lengthened or continued) the lines you have traced on the glass, you will see that they meet the vanishing point. You will also notice that the mark of the vanishing point is on a level with your eye; that is to say, on the line of sight. Naturally it follows that all lines in the object parallel with the edges of your glass are also parallel with your line of sight, and can therefore be drawn horizontally on your glass.

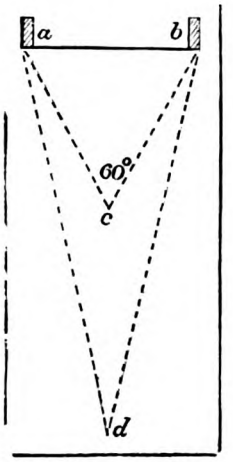


Fig. 16.—A problem in Perspective

There are two sorts of Perspective, according to the position in which objects are placed — (1) parallel perspective, and (2) angular perspective.

(1) Parallel Perspective applies to objects of a rectangular form, e.g. the interior of a room, a table, when these things are placed so that their retiring sides are at right angles with the picture plane, and the remaining sides are parallel to the picture plane (*see* **Fig. 17**).

(2) Angular Perspective applies to objects of the same form as dealt with in parallel perspective only when they are so placed that all their sides form retiring lines. Stand in a corner of a square room and you will see what is meant. One of the angles is towards the picture plane and the four sides retire.

Parallel perspective is much simpler than angular

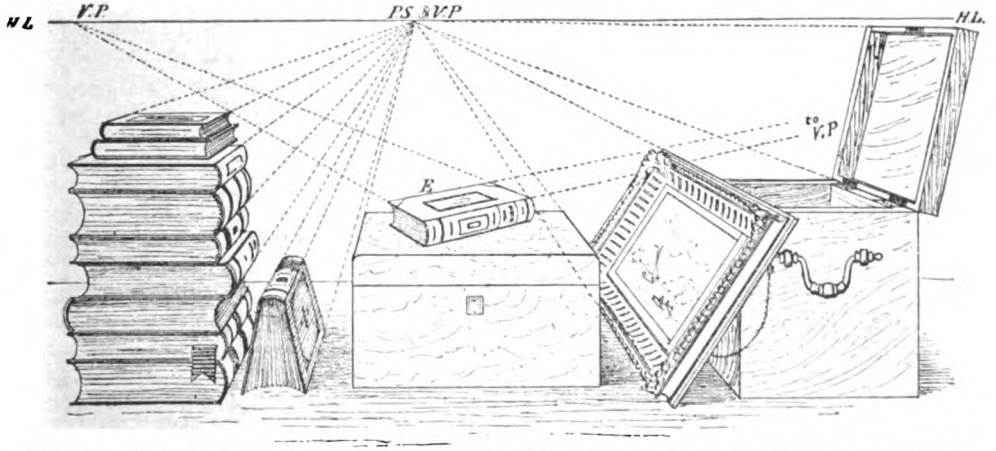


Fig. 17.—A diagram to simplify the beginner's difficulty in dealing with Parallel Perspective.

perspective, and more easily mastered. It should therefore, be dealt with in the first instance.

Turn now to the diagram of the street, and draw the horizontal line H.L., and mark on it the point which is the vanishing point and the point of sight. In this particular instance these come exactly in the middle of the line H.L.; and you will see what you have already learned, that the vanishing point and the point of sight fall together.

Much help in ordinary per pective will be derived from geometrical perspective, which will be dealt with in its turn.

From an etching by F. Laing.

An etching of Milne's Court which, unlike Hogarth's work, is a triumph of wealth of detail combined with economy of line.

In the matter of retiring lines, you cannot possibly seek a better example than a straight stretch of the railway. If you stand between the metals or on a bridge over them you will observe that the lines seem to run together in the distance. The point of their convergence is the vani hing point. The pavement in the diagram of the street above is the most highly important of all the exercises mentioned in this lesson. You will see that the retiring lines in the pavement might well stand for the metals on a railroad. The principle which governs the drawing of both objects is the same.

No subject is so well treated by the art of etching as that which includes old buildings, old houses, queer wynds and twisting alley-ways. What may be called the "soft darkness" of tone in an etching is peculiarly in keeping with the spirit of what is ancient and mellow.

In the accompanying reproduction of the picture by F. Laing you will see an admirable example of this quietly suggested mellowness. The beautiful old bow-fronted window of the little shop with the dense blackness of the open doorway beside it are delightfully rendered. The passage leading through to the next street should be carefully observed by the student as a lesson in perspective. Note the retiring line of the top of the passage wall, and the manner in which steps leading down or else a sharp slope (it is impossible to see which) are suggested. The main part of the picture, it will be seen, is in a subdued tone, but the glimpse of the street beyond is much lighter, or rather it appears so by contrast with the dark passage. The attitudes of the women and children, roughly sketched in as they are, are felicitously caught. Taking the picture as a whole, you will notice the economy of lines. And yet the detail grows upon you after a time, not by way of precise drawing hidden amid a wealth of objects as in Hogarth's work, but sheer impressions which after a moment's regard leap to the eye and take on a reality which at first glance would seem impossible. As an instance of this, observe the attitude of the old lady walking along the pavement. This pavement has a sharp slope, and the gait of a stout old woman going uphill is remarkably suggested.

The architrave over the passage entry, with its crumbling stonework, is a triumph of simple straightforward drawing. How many artists forget the extraordinary pleasure to the eye to be derived from the simplest object carefully drawn.

Whilst on the subject of etching, it may be said that not only are old buildings, houses, colleges, churches, etc., peculiarly well treated by this method, but old interiors also. Carved woodwork, panelling, and furniture, rich as they are in subdued colouring, can be most faithfully and—more important—sympathetically expressed by the etcher. It is a curious fact that even black and white can suggest colour when that method is used by a master, and in the same spirit etching is well fitted for the suggestion of age and of certain textures.

J. G. B. L.

Continued from page 171

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc. (Lond.).

MAPS AND MAP-READING

As has already been shown (see page 169), in order to determine the position of a place on the globe, reference is made to two fixed standard lines, (*a*) the equator, running round the middle of the globe, and (*b*) a line at right angles to the equator and passing from pole to pole through the Greenwich Observatory (Fig. 10).

This latter line is called the Prime Meridian.

Places to the east of it are, as we have seen, in east longitude; places to the west of it are in west longitude. Before a point can be fixed, however, its latitude must be known as well—that is, its position north or south of the equator. Places north of the equator are in north latitude; places to the south are in south latitude. Measurements are made in degrees. Latitude extends from 0° to 90° north or south, and longitude from 0° to 180° east or west.

Fig. 10.—Equator and Prime Meridian.

On some maps of the World certain parts are much larger in proportion to the rest than they are on other maps of the World; and further, that on many maps the regions which lie on the outskirts of the area shown appear to be much distorted.

These are the consequences of attempting to represent the *curved* surface of the Earth upon a *flat* map. The only correct map of the World is the globe; maps of very large areas should be curved to correspond with the earth's curvature over such areas.

Mapmakers have attempted to overcome the difficulty by a device known as *Map Projection*.

These attempts have been successful only to a limited extent.

The three important qualities to be sought in a map are (1) truth of shape; (2) truth of area: (3) truth in relative position.

The mapmaker has found it impossible to retain all these qualities in any one projection. He accordingly takes into consideration which quality is most important in the map he is to make. If truth of area is essential, he must sacrifice one, perhaps both of the other qualities; and so forth. Hence it is that one meets with a variety of map-nets, each of which has at least one good quality in spite of its bad ones. The greater the area to be mapped, the greater is the mapmaker's difficulty, for no map-net can be exactly like that used on the globe.

The *Orthographic Projection*, used to show the hemispheres, has a net which resembles the arrangement of parallels and meridians seen in a picture or a photograph of a globe. Towards the edge of the hemisphere, the parallels and meridians are crowded together; the parallels being straight lines and the meridians curves (Fig. 11).

The middle of the map is fairly correct in all three essentials; near the edge, however, there is distortion by diminution. This, of course, is unavoidable.

Another plan for mapping a hemisphere is the *Stereographic Projection*, in which the eye is supposed to be looking at a concave hemisphere as it would be seen from a point on the equator at the surface of the hemisphere opposite.

The effect is to cause distortion by exag-

geration at the edges of the map, where parallels and meridians appear wider apart than they are in the middle of the map. Here again the middle of the map is fairly correct (Fig. 14).

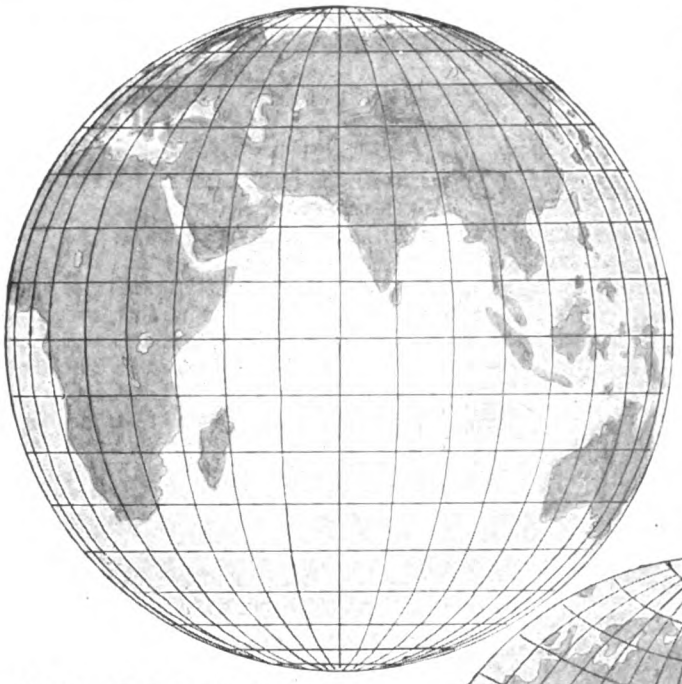


Fig. 11.—Orthographic Projection.

The *Globular* or *Equidistant Map-net* is an attempt to compensate for the errors of both Orthographic and Stereographic nets. It is the one now commonly used for showing hemispheres. It will be seen that the parallels cut the central meridians at equal distances apart; and that the meridians similarly cut the equator at equal distances apart. Its disadvantage is that the scale differs in various parts of the map. But the shape of the continents is much more correct than in either the Orthographic or the Stereographic map (Fig. 12).

Mercator's Projection is the familiar rectangular map-net of the world. It has the disadvantage of great lateral distortion to north and south, as may be expected when we see that the North Pole—a *point* on the earth's surface—is exaggerated laterally to form a line equal in length to the equator!

Its great advantage is that it shows correct relative position. The true direction of any point from another may be found by joining the points by a straight line. The advantage of using this for charts is obvious. Sailors, however, do not usually sail in the direction thus indicated, for it does not give the shortest distance between the points, but only their true direction in relation to each other. It pays sailors to follow a Great Circle course, which they work out mathematically. The shortest distance between any two points on the Earth's surface is along the arc of a Great Circle passing through the points.

The *Conical Map-Net* (Fig. 15) is most frequently used for maps of individual countries. The principle of its construction can be followed by reference to the figure on p. 240. It is remarkably correct, unless the area mapped extends over a wide range of latitude, when there is distortion at north and south.

Fig. 12.—Globular Projection.

A useful net for World maps, in which truth of area is the great essential, is the *Homalographic Projection.* There is great distortion of shape at the edge of the map,

but a square inch taken anywhere on it represents the same area always (Fig. 13).

When a traveller has finally and accurately ascertained the latitude and longitude of a number of points, he can easily plot them on a suitable map-net. Topographical details can be added after careful survey with the plane-table or the theodolite.

The most accurate maps are those made in civilised countries by a government staff of surveyors, who go over every accessible inch of the country. In Britain this is the work of the Ordnance Survey, whose maps are the most accurate and the most detailed we can obtain.

Ordnance Survey Maps are on different scales according to the amount of detail required. The most useful are the Town Plans on a scale of 126·720 inches to the mile ($\frac{1}{5000}$ of natural scale); Parish Plans on a scale of 25 inches to the mile ($\frac{1}{2500}$); the Six-inch map (six inches to the mile); and the One-inch map ($\frac{1}{63360}$ of natural scale). All these are suitable for the detailed study of a region; for more general studies one can use the Half-inch (1 in. = 2 miles), the Quarter-inch (1 in. = 4 miles), or the map on a scale of 10 miles to the inch.

On Ordnance Survey Maps details are indicated according to a recognised set of symbols, as shown in the explanatory diagram issued by the department.

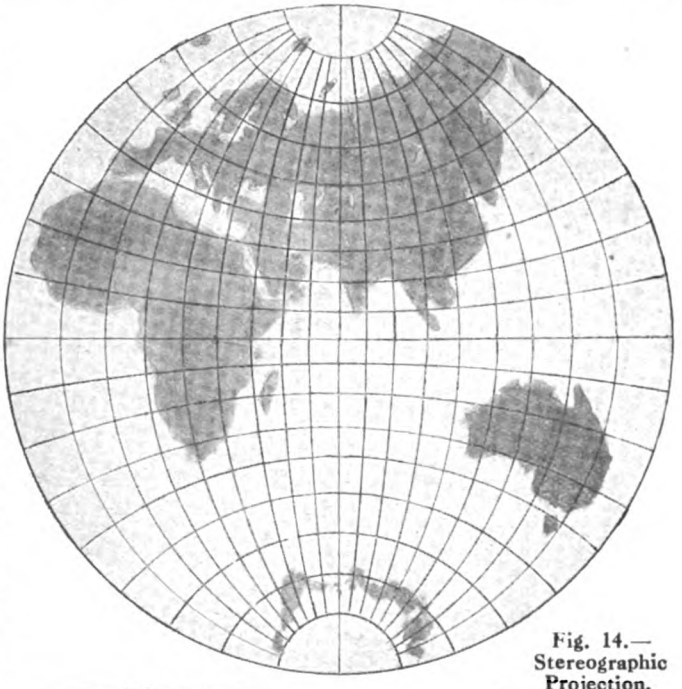


Fig. 14.—Stereographic Projection.

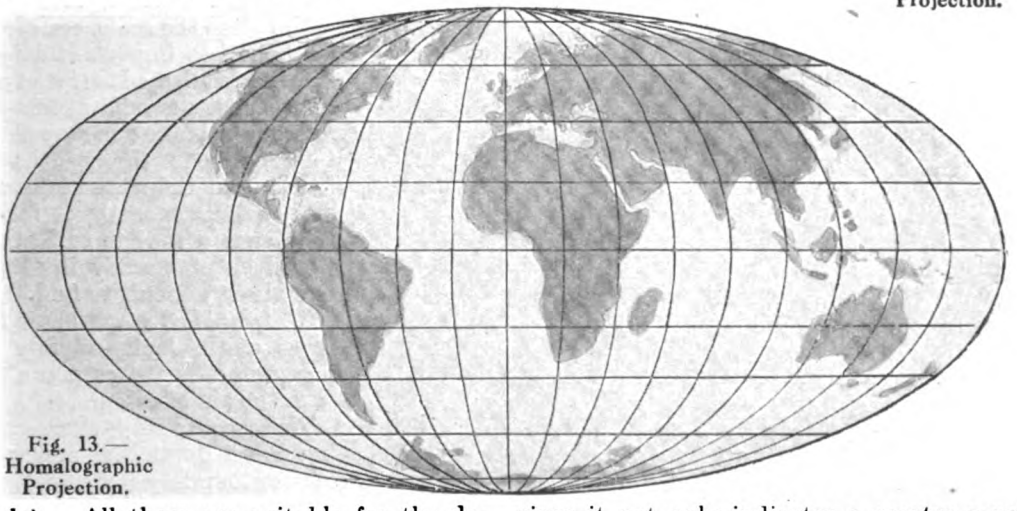


Fig. 13.—Homalographic Projection.

Differences of level are indicated on maps in a number of ways. Among the chief are: (1) By shading or flat-tinting; (2) by hachuring; (3) by contours. Of these the method of contouring is most satisfactory, since it not only indicates a greater range of differences in level but it gives actual altitudes. Other methods merely indicate the position of the highest land only, without suggesting its actual height.

Contours are lines drawn on maps joining points which lie at the same height above sea-level. They are usually drawn for a set vertical interval—for every 100 ft. rise, say. Very little practice in reading contours en-

ables one instantly to visualise the "relief" of the land from the contoured map. The spaces between the contours are frequently coloured according to a definite plan to help the eye in visualising the land-relief.

The student should study the typical contour-arrangements here given so that he can instantly recognise and interpret them.

An aid to the interpretation of a contoured map is the exercise of making sections across it along lines which cross characteristic pieces of country.

The process is simple, as may be seen by reference to Fig. 16, which is self-explanatory. Construct a vertical scale on which to build up the contours; drop perpendiculars from the points at which the line of section cuts the various contours; plot out the points on the section according to the contours from which the respective perpendiculars fall; join the points neatly in a curve. This is the profile along the line of section.

The student should practise not only the interpretation of contoured maps, but also the drawing of sets of contours to represent a region described in words.

We have seen that the larger the scale of a map the greater the amount of detail possible. If we decrease the scale, certain of the less important details must be eliminated. Further, it may be necessary, in order to make our map clear, to exaggerate the widths of rivers, and the sizes of towns, on small-scale maps; for if they were drawn to scale they would be practically invisible, or at least difficult to find.

Orographical maps show the relief of the land—usually by a system of contours, and often with the aid of colours.

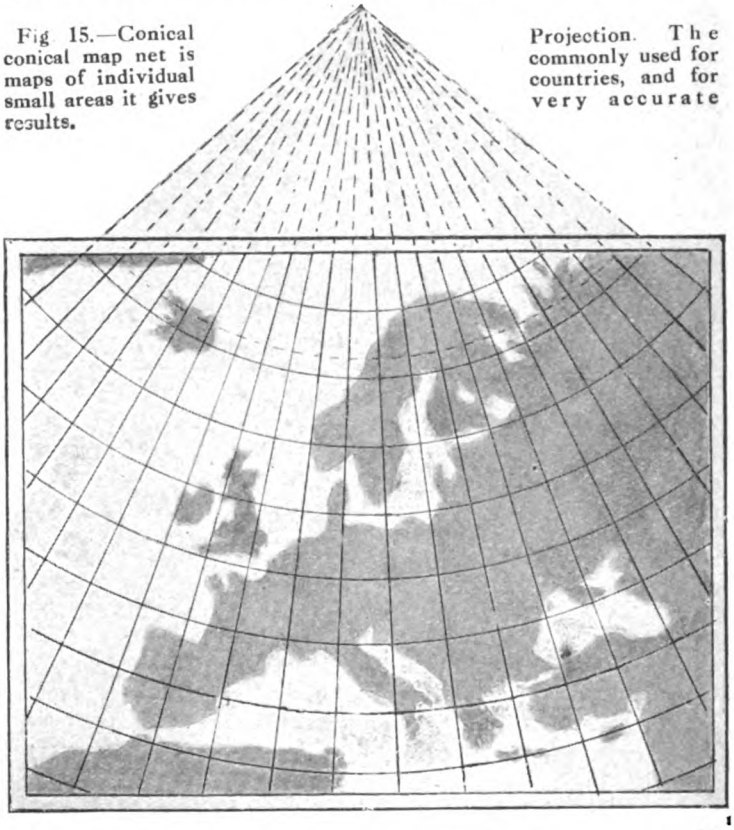
Bathymetric maps show varying ocean depths by means of sea-contours.

Bathy-orographical maps are a combination of both the foregoing.

There are also special maps to show rock-structures (geological maps), climate, distribution of population, industries, races, religions, and so forth. Examples of all these will come within the student's experience during the course of his study of this work.

R. F.

Fig. 15.—Conical Projection. The conical map net is commonly used for countries, and for maps of individual small areas it gives very accurate results.



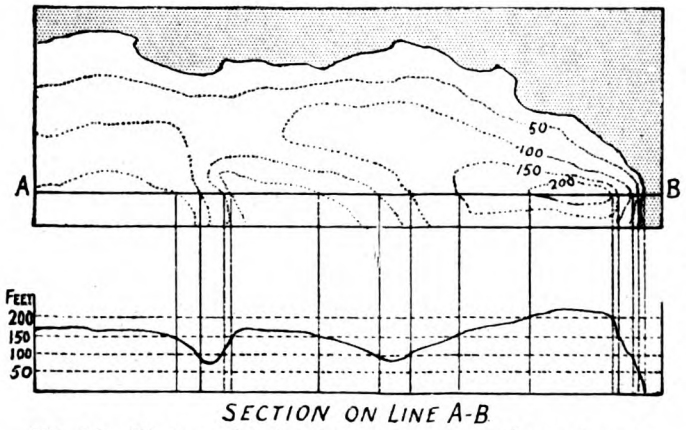
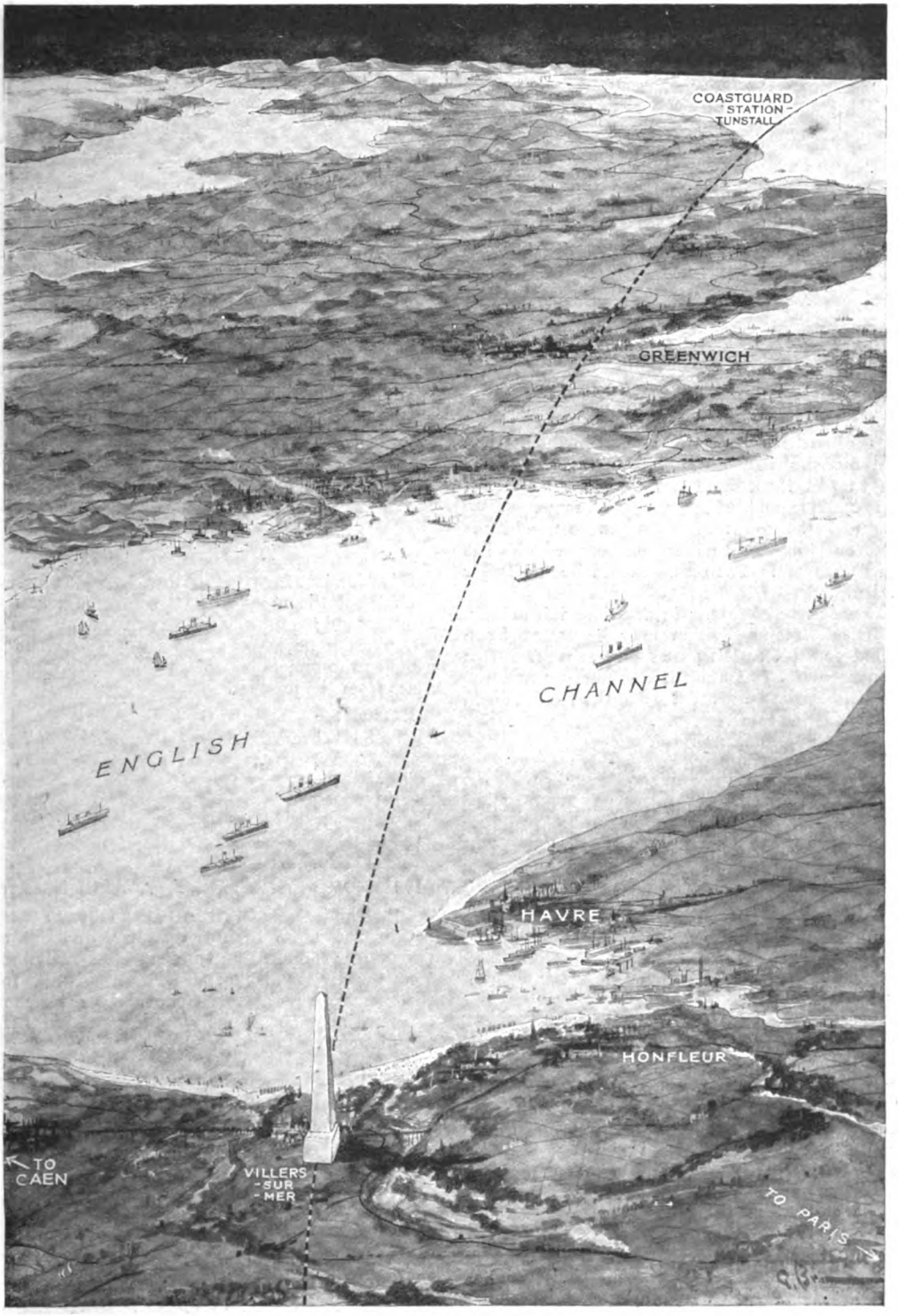


Fig. 16.—Diagram showing how to map out the contour or profile of a line A B drawn across a piece of country.



THE PRIME MERIDIAN.

The white stone near Villers-sur-Mer shows where the Greenwich meridian—of vital importance in the calculation of time and the making of maps—first touches the soil of France.

Continued from page 183

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—IV

28. Accuracy of results.—It is hardly necessary to point out to the student the extreme importance of accuracy in arithmetic. To test the result of **addition** it is a good plan first to add the columns from the bottom to the top, and then to add them from the top to the bottom. Both results should, of course, be the same.

To test the result of **subtraction**, add the difference to the smaller number which has been subtracted. The result should be the larger number.

The accuracy of results in addition, subtraction, multiplication and division may be tested by a method called **Casting out the nines.** This depends on the fact that, if any number and the sum of its digits be divided by 9, the remainder in each case is the same.

Consider any number 58432.

$$58432$$
$$= 50000 + 8000 + 400 + 30 + 2$$
$$= 5(9999+1) + 8(999+1) + 4(99+1) + 3(9+1) + 2$$
$$= 5\times9999+5+8\times999+8+4\times99+4+3\times9+3+2$$

Since 5×9999, 8×999, 4×99, 3×9 are all exactly divisible by 9, the remainder, when 58432 is divided by 9, will be the same as when $5 + 8 + 4 + 3 + 2$ is divided by 9.

Thus, to find the remainder when 658492 is divided by 9.

$2 + 4 = 6$ (pass over the 9), $6 + 8 = 14$, $1 + 4 = 5$, $5 + 5 = 10$, $1 + 0 = 1$, $1 + 6 = 7$.

Or the same result may be obtained by adding all the digits (of course, leaving out the 9 which obviously will not affect the result) thus, $2 + 4 + 8 + 5 + 6 = 25$, $2 + 5 = 7$.

29. The test for **addition** is as follows:

Cast out the nines from each of the numbers to be added; then cast out the nines from the sum of the remainders thus found; this should give the same result as casting out the nines from the total.

Example:—

4753	remainder	= 1	} remainder = **3**
812	,,	= 2	
965047	,,	= 4	
85541	,,	= 5	
1056153	remainder	= **3**,	∴ result is correct.

30. The test for **subtraction** is as follows: Cast out the nines from each number and from the difference; add the remainder from the smaller number subtracted to the remainder from the difference, casting out nine again if necessary. The result should be the same as the remainder from the larger number.

Example:—

8951032	remainder	= **1**	
760518	,,	= 0	} remainder = **1**
8190514	remainder	= 1	

∴ result is correct.

31. The test for **multiplication** is as follows:

Cast out the nines from the multiplier and the multiplicand; multiply the remainders, casting out nines if necessary; the result should be the same as the remainder obtained by casting out the nines from the product.

Example:—

598471	remainder	= 7	} remainder = 7×1 = **7.**
30052	,,	= 1	
1196942			
2992355			
1795413			
17985250492	remainder	= **7**,	∴ result is correct.

32. The test for **division** is as follows:

Cast out nines from the divisor, quotient and remainder; multiply together the remainders from the divisor and quotient, and add that from the remainder; the result should be the same as the remainder obtained by casting out nines from the dividend.

Example:—

$$\begin{array}{r} 1345 \\ 47581\overline{)64030715} \\ 16449 \\ 21754 \\ 27217 \\ 34270 \end{array}$$

47581	remainder	= 7	} $(7\times4)+7=35$ remainder = **8.**
1345	,,	= 4	
34270	,,	= 7	
64030715	remainder	= **8**,	∴ result is correct.

33. The following hints may prove useful:

Addition.—When adding 9, remember that $9 = 10 - 1$. When adding 11, remember that $11 = 10 + 1$. When mentally adding numbers of two digits, add the tens first and then the units.

Thus, 97 + 46 should be added in this way, 97 + 40 = 137, 137 + 6 = 143.

Numbers of three digits should be treated in the same way.

Thus, 695 + 347 should be added in this way: 695 + 300 = 995; 995 + 40 = 1035; 1035 + 7 = 1042.

Multiplication.—When multiplying by 25, remember that $25 = \frac{100}{4}$, i.e. add two noughts to the multiplicand and divide by 4.

When multiplying by 75, remember that $75 = \frac{300}{4}$, i.e. multiply by 3, add two noughts and divide by 4.

Division.—When dividing by a factor of 10, 100, 1000, etc., it is often simpler to multiply by the other factor and divide by 10, 100, etc.

Thus, to divide by 25, it is best to multiply by 4 and divide by 100, but it must be remembered that as the dividend has been multiplied by 4, the remainder is also multiplied by 4, and ∴ to get the true remainder you must divide again by 4.

Exercise 8

(1) How many words are there in a book of 492 pages if there are 13 words in each line and 42 lines on each page? (2) If you have £625 to divide equally among 25 people, how much will each get? (3) A garrison of 200 men have provisions for 28 days; at the end of 7 days reinforcements arrive, and then there are provisions left for only 10 days. Of how many men did the reinforcement consist? (4) If 1600 men have provisions for 3 months, how many men must leave in order that the provisions may last 5 months? (5) A motor-car and a motor-bicycle cost £480, and the car costs 7 times as much as the bicycle. How much did each cost? (6) What will be the length of a remnant of silk, if as many lengths as possible, 11 yds. long, are cut off a piece of 108 yds.? (7) A man starts on a bicycle and travels at the rate of 12 miles an hour. After 2 hours a second man starts after him and travels at the rate of 18 miles an hour. How long will it take the second man to overtake the first?

Greatest Common Measure or Highest Common Factor

34. A **Measure** of any given number, is any number which will divide the given number exactly.

Thus 3 and 17 are both measures of 51.

A **Multiple** of a given number is a number which contains the given number an exact number of times.

Thus 10 is a multiple of 2.

A **common measure** or **common factor** of two or more given numbers, is a number which will exactly divide the given numbers.

Thus 7 is a common measure or common factor of 14, 35 and 63.

The **Greatest Common Measure** or **Highest Common Factor** of two or more given numbers, is the greatest number which will exactly divide the given numbers.

Thus 14 is the G.C.M. (Greatest Common Measure) or H.C.F. (Highest Common Factor) of 28, 42 and 56.

35. The following conditions of divisibility will be found useful:

(1) Every even number is divisible by **2.**

(2) Every number whose last digit is 0 or 5 is divisible by **5.**

(3) A number is or is not divisible by **4** or **25** according as the last two digits of the number are or are not divisible by 4 or 25 respectively.

Thus, 649874812 is divisible by 4, since 12 is divisible by 4.

(4) A number is or is not divisible by **8** or **125** according as the last three digits are or are not divisible by 8 or 125 respectively.

Thus, 1005488972 is divisible by 8, since 72 is divisible by 8.

(5) A number is or is not divisible by 3 or 9 according as the sum of its digits is or is not divisible by 3 or by 9. (*See* § 28.)

(6) A number is or is not exactly divisible by 10, 100, 1000, etc., according as its last digits are or are not 0, 00, 000, etc.

(7) A number is exactly divisible by 11 if the difference between the sum of the first, third, fifth, etc. digits and the sum of the second, fourth, sixth, etc. digits is 0 or a multiple of 11.

Thus, 78584 is exactly divisible by 11, for 4 + 5 + 7 = 16, and 8 + 8 = 16, and 16 − 16 = 0.

The reason for this is as follows:

$$\begin{aligned} 10 &= 11 - 1 \\ 100 &= 99 + 1 \\ 1000 &= 1001 - 1 \\ 10000 &= 9999 + 1 \end{aligned}$$

Hence, the tens figures will give so many complete elevens minus the value of the digit (e.g. 80 = 8 × 11 − 8); the hundreds give so many complete elevens plus the value of the digit (e.g. 400 = 36 × 11 + 4), etc. So that the remainders in each case are alternately − and +, and consequently if they cancel out, or if they leave a total remainder divisible by 11, the whole is divisible by 11.

36. The following theorems are important:

(1) Every factor of each of several numbers is a factor of their sum and of their difference.

(2) Every factor of a number is a factor of any multiple of that number.

(3) Every factor of two numbers is a factor of the sum, and of the difference of any multiples of the numbers.

37. If we wish to find the H.C.F. of numbers which can easily be resolved into prime factors, we proceed as follows:

To find the H.C.F. of 72, 108 and 180.

$$\begin{aligned} 72 &= 8 \times 9 &&= 2^3 \times 3^2 \\ 108 &= 4 \times 27 &&= 2^2 \times 3^3 \\ 180 &= 4 \times 9 \times 5 &&= 2^2 \times 3^2 \times 5 \end{aligned}$$

Here we see that the highest power of 2 which will exactly divide the three numbers is 2^2, and the highest power of 3 which will exactly divide the three numbers is 3^2. Thus, the highest number which will exactly divide all three numbers is $2^2 \times 3^2 = 4 \times 9 = 36$, i.e. the H.C.F. is **36.**

38. If, however, the numbers of which we wish to find the H.C.F. cannot easily be resolved into prime factors, we proceed thus:

To find the H.C.F. of 1517 and 1927.

Any common factor of 1517 and 1927 is also a factor of their difference, § 36 (1), i.e. of 1927 − 1517, i.e. of 410.

Any factor of 410 is a factor of any multiple of 410, § 36 (2). Now if we divide 1517 (the smaller of the two original numbers) by 410, we find that $1517 = 3 \times 410 + 287$.

Any common factor of 1517 and of 3×410 is a factor of their difference, i.e. of $1517 - 1230 = 287$.

Again, any common factor of 410 and 287 is a factor of their difference, i.e. of $410 - 287 = 123$.

Any common factor of 287 and 123 is a common factor of 287 and 2×123, i.e. of 287 and 246, and is a factor of their difference $287 - 246$, i.e. of 41.

Now we know that 41 is a prime number, and no number greater than 41 can be a factor of 1517 and 1927, for we have shown that any common factor of them must also be a factor of 41.

∴ **41** is the H.C.F. of 1517 and 1927.

We have then the following rule:

Divide the larger number by the smaller; if there be a remainder, divide the smaller number by the remainder; if again there be a remainder, divide the last divisor by this and continue the process until no remainder is left. The last divisor is the H.C.F.

To find the H.C.F. of 80784 and 536976

```
                6
80784)536976      1
      52272)80784      1
            28512)52272      1
                  23760)28512      5
                        4752)23760
                             .....
                             ----
∴ the H.C.F. = 4752
```

To find the H.C.F. of three or more numbers, find the H.C.F. of the first two numbers, then find the H.C.F. of the third number and the H.C.F. of the first two. Then find the H.C.F. of the fourth number and the last H.C.F. found, and so on.

Exercise 9

Find by resolving into prime factors the H.C.F. of the following: (1) 32 and 56. (2) 55 and 75. (3) 108 and 132. (4) 128 and 321. (5) 273 and 312. (6) 100, 105, 120, 130. Find the H.C.F. of: (7) 5544 and 6552. (8) 35175 and 236845. (9) 5411728 and 10902416. (10) 274855 and 15619617. (11) 396, 5184 and 6914. (12) 4732, 5824 and 6643. (13) 1355, 1897, 2439 and 2981. (14) 7360, 9936, 16560 and 11408.

Key to Exercise 6

(1) 116. (2) 217. (3) 4437. (4) 35984. (5) 431376. (6) 23,034,265. (7) 998,405. (8) 39,672,288. (9) 7,054,719,663. (10) 144,978,925,792. (11) 2,634,368,924,460. (12) (*a*) 210,915,611,668,680; (*b*) 608,886,869,664,304; (*c*) 11,496,744,675,908,404. (13) (*a*) 262,582,983; (*b*) 51,547,963,962,254,760.

M. A. L.

ALGEBRA.—IV

FUNDAMENTAL LAWS (*continued*)

30. Properties of 0.

If a be any finite quantity, and b be any finite quantity or 0, then by what we have shown before,

$$(+a - a) \times b = +(ab) - (ab),$$

i.e. $$0 \times b = 0;$$

and if b have the particular value 0,

$$0 \times 0 = 0.$$

Again, if b be any finite quantity *other than* 0,

$$(+a - a) \div b = +(a \div b) - (a \div b),$$

i.e. $$0 \div b = 0.$$

0 cannot be looked upon as an ordinary operand. If we take any finite quantity a, and divide it by some small quantity less than 1 and greater than 0, we shall get a quotient greater than the dividend a. The smaller we make the divisor, the greater the quotient becomes, and by making the divisor sufficiently small we may make the quotient greater than any given quantity whatever; and as the divisor approaches the value 0 the quotient becomes infinitely great.

31. Indices.

$a^2 = a \times a$ by definition.

$a^3 = a \times a \times a$ by definition.

$$a^2 \times a^3 = (a \times a) \times (a \times a \times a)$$
$$= a \times a \times a \times a \times a \quad (2 + 3) \text{ factors,}$$

by definition $= a^{2+3} = a^5$.

In general, where the indices are positive integers,

$$a^m \times a^n \times a^p \times \ldots\ldots$$
$$= a \times a \times a \times \ldots\ldots m \text{ factors}$$
$$\times a \times a \times a \times \ldots\ldots n \text{ factors}$$
$$\times a \times a \times a \times \ldots\ldots p \text{ factors}$$
$$\times \ldots\ldots$$
$$= a \times a \times a \times a \times \ldots\ldots (m + n + p + \ldots) \text{ factors}$$
$$= a^{m+n+p+\ldots\ldots}$$

Hence **the index of the product of two or more powers of the same base is equal to the sum of the indices of the factors.**

We may note here that

since $(-a) \times (-a) = +a^2 = (+a) \times (+a)$

it follows that the square root of a^2 is either $+a$ or $-a$. This is usually written $\sqrt{a^2} = \pm a$, the double sign $\pm$ standing for "plus or minus."

Again—

$$a^5 = a \times a \times a \times a \times a$$
$$a^3 = a \times a \times a$$
$$a^5 \div a^3 = a \times a \times a \times a \times a \div (a \times a \times a)$$
$$= a \times a \times a \times a \times a \div a \div a \div a$$
$$= (a \div a) \times (a \div a) \times (a \div a) \times a \times a.$$

Here we have three pairs of the mutually inverse operations $a \div a$ which $= 1$, and a repeated $(5 - 3)$ times ($= 2$ times) as a factor.

$$\therefore a^5 \div a^3 = 1 \times 1 \times 1 \times a \times a$$
$$= a \times a$$
$$= a^{5-3}$$
$$= a^2.$$

In general, where m and n are positive integers,

$$a^m \div a^n = (a \times a \times a \times \ldots\ldots m \text{ factors})$$
$$\div (a \times a \times a \times \ldots\ldots n \text{ factors})$$
$$= a \times a \times a \times \ldots\ldots m \text{ factors}$$
$$\div a \div a \div a \div \ldots\ldots n \text{ divisors.}$$

Where $m > n$

$= (a \div a) \times (a \div a) \times (a \div a) \times \ldots n$ pairs
$\times a \times a \times a \times \ldots . (m-n)$ factors
$= a \times a \times a \times \ldots . (m-n)$ factors
$= a^{m-n}$.

Where $n > m$ the number of divisors is greater, and we therefore have

$a^m \div a^n = (a \times a \times a \times \ldots . m$ factors)
$\div (a \times a \times a \times \ldots . n$ factors)
$= a \times a \times a \times \ldots . m$ factors
$\div a \div a \div a \div \ldots . n$ divisors
$= (a \div a) \times (a \div a) \times (a \div a) \times \ldots m$ pairs
$\div a \div a \div a \div \ldots . (n-m)$ divisors
$= (1 \times 1 \times 1 \times \ldots .)$
$\div (a \times a \times a \times \ldots . (n-m)$ factors)
$= 1 \div a^{n-m}$.

Hence, **if a higher power of a base be divided by a lower power, the index of the quotient is the difference between the indices of the dividend and the divisor.**

And

If a lower power of a base be divided by a higher power, the quotient is unity divided by the base raised to a power whose index is the difference between the indices of the divisor and the dividend.

Again, $(a^3)^2 = a^3 \times a^3$
$= a \times a \times a \times a \times a \times a$
$= a^{3 \times 2} = a^6$

and in general, where m and n are positive integers,

$(a^m)^n = (a \times a \times a \times \ldots . m$ factors)
$\times (a \times a \times a \times \ldots . m$ factors)
$\times (a \times a \times a \times \ldots . m$ factors)
$\times \ldots .$
n rows
$= a \times a \times a \times \ldots . (m \times n)$ factors
$= a^{m \times n} = a^{mn}$.

Hence **the nth power of the mth power of a base is the mn^{th} power of that base.**

Again, in general, where m is a positive integer,

$(a \times b \times c \times \ldots .)^m = (a \times b \times c \times \ldots .)$
$\times (a \times b \times c \times \ldots .)$
$\times (a \times b \times c \times \ldots .)$
$\times (a \times b \times c \times \ldots .)$
$\times \ldots .$
m rows;

reversing the rows and columns,

$= (a \times a \times a \times \ldots . m$ factors)
$\times (b \times b \times b \times \ldots . m$ factors)
$\times (c \times c \times c \times \ldots . m$ factors)
$\times \ldots .$
$= a^m \times b^m \times c^m \times \ldots .$

Hence **the mth power of a product of bases is the product of the mth powers of the factors.**

And finally, in general, where m is a positive integer,

$(a \div b)^m = (a \div b) \times (a \div b) \times (a \div b) \times \ldots m$ pairs
$= a \times a \times a \times a \times \ldots . m$ factors
$\div b \div b \div b \div \ldots . m$ divisors
$= (a \times a \times a \times \ldots . m$ factors)
$\div (b \times b \times b \times \ldots . m$ factors)
$= a^m \div b^m$.

Hence **the mth power of a quotient of two bases is the quotient of the mth powers of the bases.**

32. In dealing with a rational term such as

$$(2a)^3 \times (4ab)^2 \div (ab^2c)^2 \times (c^2)^3 \times \left(\frac{a}{b^2}\right)^2$$

it is convenient to arrange it so that the numerical operands come together and can be contracted (as a rule) into one; and so that all the multiplications and divisions by the same letter come together and can be contracted into a multiplication or division by a single power of that letter.

Now $(2a)^3 = 2^3 \times a^3 = 8 \times a^3$
$(4ab)^2 = 4^2 \times a^2 \times b^2 = 16 \times a^2 \times b^2$
$(ab^2c)^2 = a^2 \times b^4 \times c^2$
$(c^2)^3 = c^6$

$\left(\frac{a}{b^2}\right)^2 = (a \div b^2)^2 = a^2 \div b^4$

$\therefore (2a)^3 \times (4ab)^2 \div (ab^2c)^2 \times (c^2)^3 \times \left(\frac{a}{b^2}\right)^2$
$= 8 \times a^3 \times 16 \times a^2 \times b^2 \div a^2 \div b^4 \div c^2 \times c^6 \times a^2 \div b^4$
$= (8 \times 16) \times (a^3 \times a^2 \times a^2 \div a^2) \times (b^2 \div b^4 \div b^4) \times (c^6 \div c^2)$
$= 128 \times a^{3+2+2-2} \times \{b^2 \div (b^4 \times b^4)\} \times c^{6-2}$
$= 128 \times a^5 \times (b^2 \div b^8) \times c^4$
$= 128 \times a^5 \times c^4 \times (1 \div b^{8-2})$
$= 128 \times a^5 \times c^4 \times 1 \div b^6 = \frac{128a^5c^4}{b^6}$.

The above has been worked out from first principles, and the student should at first work out all examples in this manner, but in general practice we proceed more shortly, as follows:

$$(2a)^3 \times (4ab)^2 \div (ab^2c)^2 \times (c^2)^3 \times \left(\frac{a}{b^2}\right)^2$$
$$= \frac{8a^3 \times 16a^2b^2 \times c^6 \times a^2}{a^2b^4c^2 \times b^4} = \frac{128a^7b^2c^6}{a^2b^8c^2}$$
$$= \frac{128a^5c^4}{b^6}$$

Exercise 3

Reduce to their simplest form—

(1) $12a \div 3a$. (2) $6a \times 4a$. (3) $15a^2 \div (-5a)$.
(4) $17a^3 \times (-a^2)$. (5) $-2a^3b^5c^4 \times 4a^6b^4c^5$.
(6) $24a^8b^6c^5d^3 \div (-6a^4b^4c^4d)$.
(7) $14x^2yz \div 7xy^2z^2$.
(8) $-6x^3y^3z^3 \times 3xy^4 \div 9yz^3$.
(9) $\left(\frac{15a^4b^3x^2yz^3}{75a^2bx^3y^2z}\right) \times \left(\frac{abxy^3z^2}{a^3b^2x^4yz^3}\right)$.
(10) $\left(\frac{a^4}{b^2}\right)^3 \left(\frac{a^2}{b^3}\right)^2$. (11) $[\{(a^3)^2\}^3]^5$.
(12) $(\ldots .[\{(x)^1\}^2]^3 \ldots .)^m$.

33. Having established the fundamental laws of Algebra, we can now proceed.

Addition.—By the Law of Association we know that $+(+a) = +a$ and $+(-a) = -a$. Regarding the + sign outside the bracket as a sign of addition, we conclude that **to add any algebraic quantities we write them down with their signs unchanged.**

Thus, the sum of $3a - 4b + 5c$ and $-6d + 7e + 8f$ is $3a - 4b + 5c - 6d + 7e + 8f$.

If in such a sum there are two or more **like terms,** they must be combined into one term by

taking the **algebraic sum** of their numerical coefficients and prefixing it to the letter or letters

Thus $+2a+3a=+5a$
$-2a+3a=+1a=+a$
$+2a-3a=-1a=-a.$

Examples :—

(1) Add $2a+5b$ and $7a-9b$.

The sum is $2a+5b+7a-9b$
$=2a+7a+5b-9b$
$=9a-4b.$

(2) Add $-3x^2+4xy-5y^2$ and $-x^2-3x^2y+7y^2$.

The sum is $-3x^2+4xy-5y^2-x^2-3x^2y+7y^2$
$=-3x^2-x^2+4xy-3x^2y-5y^2+7y^2$
$=-4x^2+4xy-3x^2y+2y^2.$

(Note that $4xy$ and $3x^2y$ are *not* like terms.)

(3) Add $2a^2-4ab+3b^2$, $-3a^2+2ab-5b^2$, $4a^2+ab-b^2$.

The sum is $2a^2-4ab+3b^2-3a^2+2ab-5b^2+4a^2+ab-b^2$,
combining like terms mentally,
$=3a^2-ab-3b^2.$

34. Subtraction.—By the Law of Association we know that $-(+a)=-a$ and $-(-a)=+a$. Regarding the $-$ sign outside the bracket as a sign of subtraction, we conclude that **to subtract any algebraic quantities we write them down with all their signs changed.**

Thus, if we subtract $a-4b+3c$ from $2a-b-3c$, the result will be $2a-b-3c-a+4b-3c=a+3b-6c$.

35. Brackets.—We noted in § 20 that there may be a cumulation of the signs + and − owing to the use of brackets within brackets. It is usual in such a case, when we remove the brackets, to remove the innermost ones first.

Example :—

$3x-[2y+\{5x-3y-(x-y)\}]$
$=3x-[2y+\{5x-3y-x+y\}]$
$=3x-[2y+\{4x-2y\}]$
$=3x-[2y+4x-2y]$
$=3x-[+4x]=3x-4x=-x.$

After a little practice the student will be able to combine like terms and remove the brackets at the same time, but he must always be very careful about the signs.

Exercise 4

Find the sum of

(1) $3a-5b$, $4a+7b$, $-2a+3b$.

(2) $2x-3y+4z$, $3x+4y-2z$, $-x-7y+3z$.

(3) $\frac{1}{2}a-\frac{3}{4}b+\frac{1}{8}c$, $-a+\frac{1}{2}b-\frac{3}{4}c$, $\frac{3}{4}a+b-\frac{1}{2}c$.

(4) $x^4-x^3+x^2$, x^3-x^2+x, x^2-x+1, x^4-x^2-1.

(5) $4x^2-7xy+6y^2$, $-2x^2+5xy-y^2$, $x^2+2xy-4y^2$.

(6) Subtract $4x-7y$ from $8x+2y$.

(7) Subtract $3m^2-4mn+5n^2$ from $4m^2-4mn+6n^2$.

Simplify—

(8) $2x-[2y+(4x-\overline{2x+y})]$

(9) $x-[x-y-\{x-y+z-(x+y-z)\}]$

(10) Subtract $4a-\{3a-(4b-c-d)\}$ from $6a-d+[3b-\{4c+d-(2a+b+\overline{c-d})\}]$

36. Multiplication.—We have dealt above in § 32 with the multiplication and division of monomials. We will now deal with the multiplication of multinomials by monomials and by other multinomials.

Example :—

(1) $(a+b+c)\times d.$

By the Law of Distribution § 27.

(2) $(a+b+c)\times d=ad+bd+cd.$

(3) $(2ax-3by)\,abxy=2a^2bx^2y-3ab^2xy^2.$

(4) $(a+b)(c+d)=ac+bc+ad+bd.$

(5) $(5ax-3by)(2ax+4by)=10a^2x^2-6abxy+20abxy-12b^2y^2$
$=10a^2x^2+14abxy-12b^2y^2.$

(6) $(x^2+2xy-y^2)(x^2-2xy+y^2)$
$=x^4+2x^3y-x^2y^2-2x^3y-4x^2y^2+2xy^3+x^2y^2+2xy^3-y^4$
$=x^4-4x^2y^2+4xy^3-y^4.$

The student may find it easier to write out a multiplication of the above kind in the following way :

$$\begin{array}{l} x^2+2xy-y^2 \\ x^2-2xy+y^2 \\ \hline x^4+2x^2y-x^2y^2 \\ \quad -2x^3y-4x^2y^2+2xy^3 \\ \qquad +x^2y^2+2xy^3-y^4 \\ \hline x^4\qquad -4x^2y^2+4xy^3-y^4. \end{array}$$

The multiplier is written under the multiplicand. The first horizontal row under the line contains the successive products of the terms of the multiplicand, multiplied by the first term of the multiplier, namely, x^2. The second horizontal row contains the products of the terms of the multiplicand and the second term of the multiplier, namely, $-2xy$, like terms being placed beneath each other, and so on until all the products are written down. Then a line is drawn, and the algebraic sum of the partial products in the columns is written down, which gives the final result.

37. The following examples are very important :

$(a+b)^2=(a+b)(a+b)=a^2+ab+ab+ab^2$
$=a^2+2ab+b^2\ldots.$ I

Thus **the square of the sum of two quantities is equal to the sum of their squares plus twice their product.**

$(a-b)^2=(a-b)(a-b)=a^2-ab-ab-b^2$
$=a^2-2ab+b^2\ldots.$ II

Thus **the square of the difference of two quantities is equal to the sum of their squares minus twice their product.**

$(a+b)(a-b)=a^2+ab-ab-b^2$
$=a^2-b^2\ldots.$ III

Thus **the product of the sum and the difference of two quantities is equal to the difference of their squares.**

A general result expressed by means of symbols is called a formula.

Since the laws on which the above formulæ depend have been proved to be true for all algebraic quantities, it follows that the formulæ hold good for any other algebraic quantities or algebraic expressions, which we may substitute for a and b.

If we put $3x$ for a and $5y$ for b in I., we have
$(3x+5y)^2=9x^2+30xy+25y^2.$

If we put $3b$ for b in III., then we have
$(a + 3b)(a - 3b) = a^2 - 9b^2$.
Now put $b + c$ in place of b in I., then
$\{a + (b + c)\}^2 = a^2 + 2a(b + c) + (b + c)^2$
$\therefore (a+b+c)^2 = a^2+b^2+c^2+2ab+2bc+2ca$ . . IV
Now put $-c$ in place of c in IV., then
$(a+b-c)^2 = a^2+b^2+c^2+2ab-2bc-2ca$ . . V
Now put $b + c$ in place of b in III., then
$\{a + (b + c)\}\{a-(b + c)\} = a^2 - (b + c)^2 = a^2 - (b^2 + 2bc + c^2) = a^2 - b^2 - c^2 - 2bc$
$\therefore (a + b + c)(a - b - c) = a^2 - b^2 - c^2 - 2bc$ . . . VI

M. A. L.

GEOMETRY.—III

Proposition 8.—Theorem

If three sides of one triangle equal the three sides of another triangle respectively, the triangles are equal in all respects.

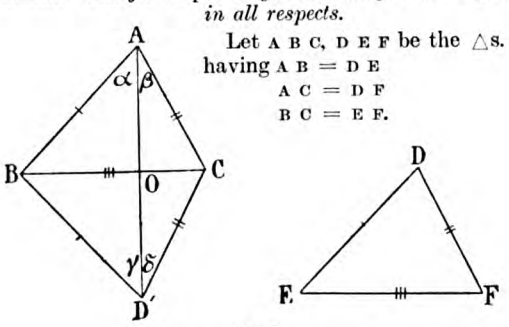


Fig. 1.

Let A B C, D E F be the △s. having A B = D E
A C = D F
B C = E F.

It is required to prove that △ A B C ≡ △ D E F.

Proof.—Apply △ D E F to △ A B C in the position D′ B C, so that E F falls on B C (this is possible since

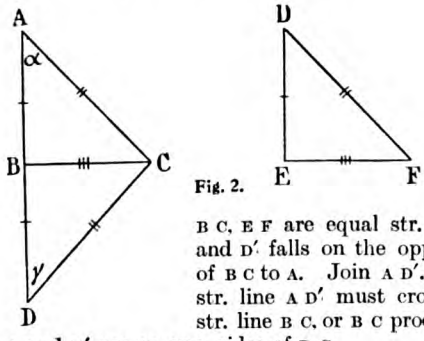


Fig. 2.

B C, E F are equal str. lines) and D′ falls on the opp. side of B C to A. Join A D′. The str. line A D′ must cross the str. line B C, or B C produced, ∵ A and D′ are on opp. sides of B C.

Let A D′ cut B C at O. Then O must lie
(1) between B and C as in Fig. 1.
(2) either at B or C as in Fig. 2.
(3) in B C produced as in Fig. 3.

Fig. 1. B D′ = B A (hypothesis).
∴ △ A B D′ is isos.
∴ $\alpha = \gamma$ (Prop. 6).
C D′ = C A (hypothesis).
∴ △ A C D′ is isos.
∴ $\beta = \delta$ (Prop. 6).
∴ ∠ B A C = $\alpha + \beta = \gamma + \delta$
= ∠ B D′ C i.e. ∠ E D F.

In △s A B C, D E F.
A B = D E
A C = D F
and included ∠ B A C = included ∠ E D F.
∴ △ A B C ≡ △ D E F (Prop. 5).

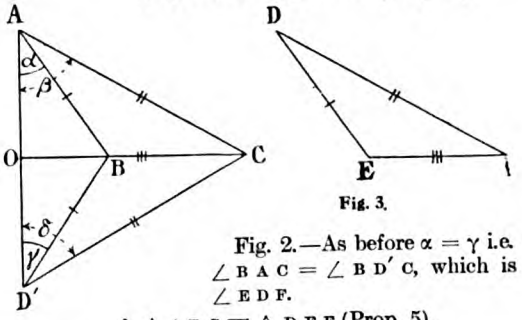


Fig. 3.

Fig. 2.—As before $\alpha = \gamma$ i.e. ∠ B A C = ∠ B D′ C, which is ∠ E D F.
∴ △ A B C ≡ △ D E F (Prop. 5).

Fig. 3.—As before $\alpha = \gamma$, $\beta = \delta$.
∴ ∠ B A C = $\beta - \alpha = \delta - \gamma$ = ∠ B D′C.
i.e. ∠ E D F.
∴ △ A B C ≡ △ D E F (Prop. 5).

Proposition 9.—Theorem

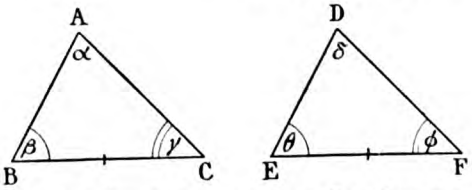
If two angles and one side of one triangle equal two angles and the corresponding side of another triangle respectively, the triangles are equal in all respects.

Let △ A B C, D E F have
B C = E F.
$\beta = \theta$
$\gamma = \varphi$

It is required to prove that △ A B C ≡ △ D E F.

Proof.—Apply △ D E F to △ A B C so that E F coincides with B C (this can be done since B C, E F are equal str. lines) and D falls on the same side of B C as A.

∵ E F coincides with B C and $\theta = \beta$
∴ E D lies along B A
and ∵ E F coincides with B C and $\varphi = \gamma$
∴ F D lies along C A.



Thus E D lies along B A and F D lies along C A.
∴ pt. of intersection of E D and F D, i.e. pt. D must coincide with pt. of intersection of B A and C A, i.e. pt. A.
∴ △ D E F coincides with △ A B C.
i.e. △ A B C ≡ △ D E F.

[**Note.**—Supposing we were given B C = E F, $\beta = \theta$, and $\alpha = \delta$, then ∵ $\alpha + \beta + \gamma = 2$ rt. ∠s ∴ $\gamma = 2$ rt. ∠s − $(\alpha + \beta) = 2$ rt. ∠s − $(\delta + \theta) = \varphi$ (since $\delta + \theta + \varphi = 2$ rt. ∠s), hence $\gamma = \varphi$, and proof is the same as above.]

Exercise 4

1. A B C, A B D are two triangles on the same side of A B, having their three sides respectively

equal. If A D meet B C in O, prove that $\triangle$ A O C $\equiv$ $\triangle$ B O D.

2. A B C D is a quadrilateral having the sides A B, A D equal, and the angles A B C, A D C equal. Show that A C bisects B D at right angles.

3. The sides A B, A D of a quadrilateral A B C D are equal, and the diagonal A C bisects the angle B A D. Show that the sides C B and C D are equal, and that the diagonal A C bisects angle B C D.

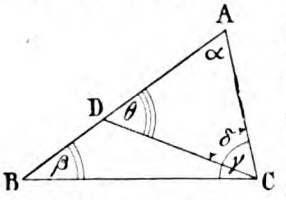
4. If two isosceles triangles are on the same base, the straight line joining their vertices, or the straight line produced, will bisect the base at right angles.

5. Draw a line A B 6 cms. long. Bisect the line at the pt. C. With centre A and radius = 5 cms. describe a circle and with centre B and radius = 5 cms. describe another circle. If one of the points of intersection of the circles be D, prove that angles D C A and D C B are right angles.

Proposition 10.—Theorem

If one side of a triangle be greater than another, the angle opposite the greater side is greater than the angle opposite the lesser side.

Let A B C be a $\triangle$ having A B > A C.



It is required to prove that $\gamma > \beta$.

Proof.—From A B cut off A D = A C.

Join C D.

θ is the ext. $\angle$ of $\triangle$ B D C.

$\therefore \theta > \beta$ (Prop. 4, Cor. 4).

Now in $\triangle$ A D C, A D = A C (construction).

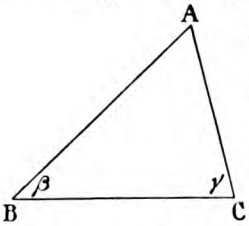
$\therefore \theta = \delta$ (Prop. 6).

But $\gamma > \delta \quad \therefore \gamma > \theta$

and $\theta > \beta \quad \therefore \gamma > \beta$

Proposition 11.—Theorem (Converse of Prop. 10)

If one angle of a triangle be greater than another, the side opposite the greater angle is greater than the side opposite the lesser angle.



Let A B C be a $\triangle$ having $\gamma > \beta$.

It is required to prove that A B > A C.

Proof.—If A B be not > A C.

(1) A B = A C

or (2) A B < A C.

Now if A B = A C, then $\gamma = \beta$ (Prop. 6) but $\gamma > \beta$ $\therefore$ this is impossible, i.e. A B does not equal A C.

And if A B < A C then $\gamma < \beta$ (Prop. 10) but $\gamma < \beta$ $\therefore$ this is impossible, i.e. A B is not less than A C.

$\therefore$ A B > A C.

Proposition 12.—Theorem

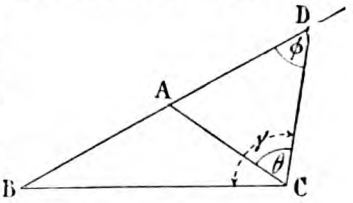
Any two sides of a triangle are together greater than the third side.

Let A B C be any $\triangle$.

It is required to prove that any two of its sides are together greater than the third.

Proof.—To prove that B A + A C > B C.

Produce B A and cut off A D = A C. Join C D.



In $\triangle$ A D C, $\because$ A D = A C (construction).

$\therefore \theta = \varphi$ (Prop. 6).

but $\gamma > \theta \therefore \gamma > \varphi$

In $\triangle$ B D C, $\because \gamma > \varphi$

$\therefore$ B D (the side opp. γ) > B C (the side opp. φ) (Prop. 11)

but B D = B A + A D

= B A + A C (since A D = A C)

$\therefore$ B A + A C > B C.

Similarly we may show that A C + C B > A B and that A B + B C > A C.

Model Exercise

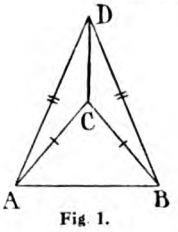


Fig. 1.

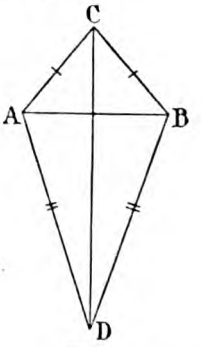


Fig. 2.

Two isosceles triangles C A B, D A B are on the same base A B. Show that $\triangle$ A C D $\equiv$ $\triangle$ B C D. We must have two figures as there are two possible cases, viz. C and D on the same side and C and D on opposite sides of A B.

Join C D.

In Fig. 1. $\because$ D A = D B $\therefore \angle$ D A B = $\angle$ D B A (Prop. 6).

and $\because$ C A = C B $\therefore \angle$ C A B = $\angle$ C B A (Prop. 6).

$\therefore \angle$ D A B $- \angle$ C A B = $\angle$ D B A $- \angle$ C B A.

i.e. $\angle$ D A C = $\angle$ D B C.

In Fig. 2. $\because$ C A = C B $\therefore \angle$ C A B = $\angle$ C B A (Prop. 6).

and $\because$ D A = D B $\therefore \angle$ D A B = $\angle$ D B A (Prop. 6).

$\therefore \angle$ C A B + $\angle$ D A B = $\angle$ C B A + $\angle$ D B A.

i.e. $\angle$ D A C = $\angle$ D B C.

In $\triangle$s A C D, B C D

A C = B C

A D = B D

and included $\angle$ D A C = included $\angle$ D B C

$\therefore \triangle$ A C D $\equiv \triangle$ B C D (Prop. 5).

Exercise 5

(1) Any three sides of a quadrilateral are together greater than the fourth side.

(2) If two right angled triangles have their hypotenuses equal, and also a side of one equal to a side of the other, the triangles are equal in all respects.

(3) The sum of the four sides of a quadrilateral is greater than the sum of the diagonals.

(4) Of all straight lines drawn from a given point to a given straight line, the perpendicular is the shortest.

M. A. L.

Continued from page 192.

BUSINESS AND COMMERCE:

Contributors :—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—IV

In these days of typewriters and other mechanical devices, one is apt to overlook the question of handwriting and the perfect legibility of pen-made figures. Yet, many a clerk has gained his first step in promotion because of his careful caligraphy.

The best way to acquire a good handwriting is to practise with the aid of a blank copy-book containing on the top line of every page clear reproductions of commercial penmanship. Such books are quite inexpensive, and though handwriting of the lithographic order is not actually required in business this method of improving one's style is highly to be commended.

From the clerk's point of view the type of penmanship to acquire is something not too large or spreading nor on the other hand too cramped and crabbed. And it must be absolutely legible. Flourishes of all kinds are taboo, and too much care cannot be exercised in making every figure perfect—5's, 3's, and 8's in particular.

When setting out a column of figures the vertical alignment must be closely considered, especially as regards money columns. Punctuation, too, should always receive careful attention.

Business Letters

It is well also to cultivate a signature that is perfectly legible. Men of business for the signing of letters, cheques and documents acquire a signature which they hardly ever vary in the minutest degree.

Good spelling, again, is very important. The clerk who constantly misspells his words cannot hope to make rapid progress.

Now, just as letters passing outwards must be copied and noted for future reference, so letters received must be filed away and a note of their existence be recorded.

Letters in business are something more than mere written messages. With personal, social letters that merely convey news, pleasantries and remembrance from one friend to another the sooner they are burned after being answered the better, for, generally speaking, there is nothing to be gained by keeping them. Business letters, however, form a permanent record of bargains and transactions, of orders and offers.

Filing Systems

In all phases of business life the written word is the superior of the spoken word. It stands to reason, therefore, that quite as much system and method must enter into the keeping and preserving of letters received as pertains to the dispatch of correspondence.

Naturally, the systems vary considerably in different offices according to the amount of correspondence the particular business entails. A small firm, for example, would not require so complete a system as a big company conducting a widespread business. In practically every office, however, the antiquated system of two dozen pigeonholes—one for I–J, another for X–Y–Z, and one each for the remaining letters—has passed completely into the background, and the new method embraces filing cabinets, filing drawers or the card-index system.

The ordinary filing system consists of sorting out the letters into strictly alphabetical order and of putting them away. In some cases box files are used, which contain stout cartridge paper partitions; in other cases a strong concertina file with pockets is employed. Some businesses utilise a cabinet of sheet steel or wood in the partitions of which the alphabetical filing of letters, documents and accounts is rendered simple.

The most simple method, employed by firms with only a small correspondence, will probably consist of a box file, divided into twenty-six compartments under the letters of the alphabet. The filing-clerk, who puts

away the letters at the close of each day, together with any documents that may accompany them, must exercise the greatest care over the following matters :—

1. All the correspondence of one particular firm or individual must appear together in the file, the latest to hand on top and the remainder in order according to date of receipt.
2. The strictest alphabetical order must be preserved, following precisely the methods of a directory. Thus, Fry, Basil would come before Fry, Brown and Co.—Ba being in advance of Br alphabetically.
3. When a letter or document is borrowed from the file, even if borrowed by the head of the firm, a note should be made of the fact and careful reminders be given from day to day until the missing sheet is returned.
4. In some offices it is the rule for the folio in the letter-book upon which the reply is copied to be entered plainly on the face of the inward letter, and where this is the case the greatest care must be exercised in executing the order.

Probably at the end of the year or half-year this box file will be put away and a fresh one commenced. In this case the dates covered by the contents of the file so relegated should be noted on the back.

The Card-Index System

There is another system of filing similar to this, but on a bigger scale, for the various compartments of the file contain upon an outside sheet of stout paper ruled spaces on which are written by the filing clerk particulars of the correspondence contained within. Merely the names and dates are given.

In some offices, especially in those of the legal fraternity, letters are folded so that the blank back is presented, and upon this are written brief notes respecting the communication, thus :—

Dated, June 22nd, 1919.
From Mrs. Bloom, of Maidstone.
In re *Investment in Victory Bonds.*
Replied to June 23rd.

This letter would then be docketed and filed with other recent ones from Mrs. Bloom.

With the very large filing cabinets, some of which have sliding shutters like that of a roll-top desk and shelves beneath for keeping filled files, much the same system of putting away correspondence alphabetically is maintained, except that instead of having one box file for the entire alphabet there is a file for almost every letter, this file in its turn being subdivided by partitions thus :—A—B, A—D, A—E, A—L, and so on.

The card-index system is a far more ambitious source of business reference than any mere filing method. Briefly, it consists of a series of cards held in position in a long box in such a way that they are strictly alphabetical and can be turned over quickly until the one desired is reached. For instance, the manager of the branch of a bank will have in his private office a cabinet containing probably twenty-four drawers, arranged alphabetically and each containing its proportion of cards. On each of these cards will appear the name of a customer, date when he opened his account, by whom he was introduced, his business and private address.

"See" Cards

Firms that employ an enormous number of responsible workers invariably have a card-index system. Doctors and dentists utilise the system for keeping close account of their patients, and card indexes figure in libraries, colleges and a multitude of other institutions.

It will readily be seen how essential and useful is the card-index system in business. Imagine for a moment a company with no fewer than five thousand individual customers, a feat requiring no great stretch of the imagination in these days of enormous limited liability houses. In the correspondence department is kept a card-index system containing five thousand cards, each numbered, each bearing plainly upon its face the name, address, telephone number, telegraphic address of every customer.

Below will appear memoranda and notes respecting this particular customer—when he was introduced and by whom, which particular commercial traveller calls upon him, what credit and what discounts he is allowed, what estimates have been given him from time to time, where he banks, and other details of this character. Sometimes there will appear what are called "See" cards. Thus, there will be a card for Messrs. Fry, Dawson & Co., of Grahametown, and there will be a card each for the principals, Messrs. George Fry and John Dawson, but on their cards will be written : "See Fry, Dawson & Co., Grahametown, No. 121." This is to serve as a check should one of the principals write individually instead of on behalf of the company.

A. B.

CHOOSING A CAREER.—IV

Emigration.—Ever since Britons first went forth and conquered lands beyond the seas, the call for colonists and emigrants, men and women, boys and girls, has become increasingly insistent.

As British Overseas Dominions have grown and developed, so has the demand for workers of almost every class increased, so that, whether the callings and professions in the Motherland be overcrowded or otherwise, there is invariably an opening in the Dominion of Canada, the Commonwealth of Australia, the Empire of India, the Union of South Africa, or a smaller colony or dependency, for enterprise and energy, capital and labour, mental effort and physical toil.

But Emigration is something even more than a trade or profession. It is the founding of a new life, the building of a fresh existence.

The individual, therefore, who contemplates emigration must weigh the issues patiently, methodically, slowly and carefully before arriving at a definite decision. Emigration is not a step to be taken lightly, nor is it a panacea for failure at home. A young man or young woman who finds the earning of a living in the United Kingdom hard and exacting will discover harder and even more exacting conditions in the Colonies, and only those who are workers, tried and proved, should ask themselves the question: "Shall I emigrate?" Shirkers and those who are work-shy stand no better opportunity in one of our Overseas Dominions than they do at home; even in our older colonies leisured classes are practically non-existent.

CANADA.—When considering emigration it is only natural that our thoughts should first turn to Canada, which, with the exception of Alaska in the north-west, and Greenland in the north-east, comprises the entire northern part of North America. So vast is this country, in fact, that it is almost as large as Europe, and covers an area more than thirty times as large as that of Great Britain and Ireland.

We mention this because so many would-be emigrants speak of "going to Canada" as though this enormous country were a mere district, presenting similar phases wherever one turns.

As a matter of fact, this particular aspect of emigration as applied to Canada is one most closely to be studied. Canada is divided into nine provinces, and the North-West Territories. Three of these provinces are maritime—Prince Edward Island, Nova Scotia, and New Brunswick; the others are Quebec, Ontario, Manitoba, Alberta, Saskatchewan, and British Columbia. Over one-third of the population of Canada is settled in Ontario.

With the aid of the map to be found on page 253 we will consider the points of the various provinces as they should appear to a would-be colonist who is carefully studying the whole subject.

Prince Edward Island is the smallest of the provinces, and yet the most densely populated. It enjoys a mild though bracing climate, and is known as the "Garden Province," grain, potatoes and turnips forming the principal crops, though fruit growing is developing very rapidly. Fishing is an important industry, and the black fox is bred and reared on many of the ranches for the high quality fur it yields. Charlottetown is the principal city.

Nova Scotia being a peninsula jutting out into the Atlantic, enjoys a climate very much like that of the Mother Country, without extremes of heat or cold. It is a great centre for fruit farms, especially for those where apples are grown, and half a million barrels of apples are exported every year to the United Kingdom. General agriculture, including the growing of cereals and of oats in particular, forms the chief occupation, and Halifax is the capital.

New Brunswick makes timber one of its most important industries, but its farms are exceptionally fertile. Market gardeners prosper here, especially near the cities, and strawberries and raspberries are grown in immense quantities. Dairy farming is a most valuable industry, and the climate is drier and more bracing than that of the British Isles. St. John is the chief city.

Quebec is occupied in the main by French Canadians, and only about one-sixth of the people are English-speaking, whilst the Roman Catholic religion largely predominates. Agriculture, fruit farming, and cheese making in particular, represent the chief industry, but tobacco is largely grown, and maple trees are cultivated for their sugar and syrup. Forestry and fishing are also important, and the quaint old city of Quebec is the capital.

Ontario, which is almost equal in area to France and Germany combined, has a population exceeding two and a half millions, of whom the great majority are of Canadian birth or British immigrants. It possesses a wonderful climate, dry and clear, with fairly severe winters, and three-quarters of

Canada's orchard lands lie in this province. Wheat, oats, and peas form the principal crops, and Ontario is famous for its horses, cattle, and sheep. Toronto is the capital, and this province is one of the best for agricultural emigrants to select.

Manitoba, which occupies the middle of the country, is the greatest wheat-growing centre in the world. The winter, which is very sharp, lasts about four months, but as the atmosphere is dry the cold is not so keenly felt. Every place of any size has mills for converting wheat into flour, and wheat growing can be carried on with less capital than would be required for mixed farming. Winnipeg, the gateway to Western Canada, is the capital.

Saskatchewan offers to the emigrant something like 150 millions of acres of land that have never been cultivated at all. In the south of the province grain growing is the great industry, but to the north cattle raising is the speciality. Regina is the capital of the province.

Alberta is the rolling, treeless prairie province, and cattle ranching is the main industry, though to the north there are forests. The summers are very hot, though there are always winds from the Rocky Mountains, but the winters are cold and extremely dry. Edmonton in the north, and Calgary to the south, are the chief cities.

British Columbia is a mineral province, but offers twenty million acres of ground suitable for grain growing, ranching, and fruit farming. It has an ideal climate, wonderful scenery and innumerable forests. This province presents splendid opportunities to the emigrant who has had experience of mixed farming, and coal miners here are particularly highly paid. It has, besides, one of the largest areas of building timber in the world. The huge Douglas firs abound along the coast, and the lumberman is able to have them towed direct to the mill. In fisheries British Columbia, with its coast line of 7,000 miles, is the richest of the Canadian Provinces. Victoria is the capital, and Prince Rupert the terminus of the Grand Trunk Pacific Railway.

It will be seen, therefore, what wide diversity exists in this great country—the older civilisation of the maritime provinces on the east, the homes of countless settlers and colonists in the centre, the gradually developing industries of the Far West. But, however much one cogitates, the one main factor stands out above all others, Canada is primarily a Dominion for Agriculturists, those who will till the soil, cultivate fruit, or raise vast herds of stock.

How, then, shall a young man set about becoming a colonist in Canada ?

Assuming that he has not actually been brought up on a farm in the Old Country, one of his first steps should be to obtain practical personal experience of agricultural work. He may do this by engaging himself as a farm hand at home, and though his wages will be small, the knowledge will prove to be invaluable later on. As an alternative, and presuming he can afford the £1 a week which the tuition will roughly and approximately cost him, he can go to an agricultural college for the special Colonists' Course.

At *University College, Reading, Berkshire; University College, Aberystwyth; Aspatria Agricultural College, Cumberland;* the *Agricultural College, Tamworth, Staffordshire;* the *Royal Agricultural College, Cirencester, Gloucestershire*, such courses are conducted, full particulars of which are obtainable by writing to the respective principals.

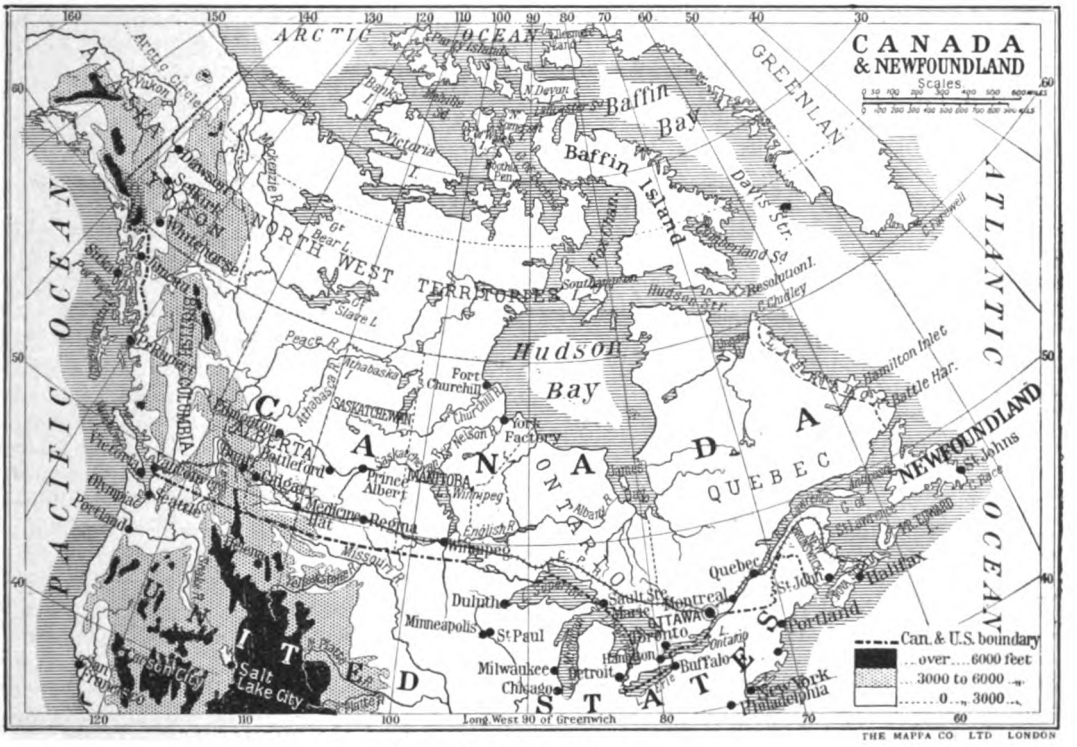
It is not advisable, however, for an emigrant to go direct to the possession of a farm or ranch of his own in Canada. A knowledge of farming at home is of immense assistance, but, after all, British methods in the Old Country are not the methods of Canada, and the routine of the new life must be mastered before embarking one's capital and one's energy on the fresh venture. It is highly advisable, therefore, that the colonist should first attend an agricultural school in Canada, and such institutions are conducted under Government authority by most of the provinces; failing this, the new-comer must put his pride in his pocket, and become the hired servant of another man, preferably for the whole year round, so that he may learn, and learn, and learn again.

Out in Canada the chief grievance the native-born farmer has against the emigrant is the fact that he claims to know too much. A lad freshly drafted from the Homeland will make the great mistake of his life if he goes to teach and not to learn.

After this period of learning, however, learning in the hard school of practical experience, the tenderfoot may take up his own holding with every confidence of success, and during that year of probation he will have acquired a knowledge of numerous pitfalls to be avoided, of traps for the new-comer, and will be acquainted with the advantages and disadvantages of many matters, the intricacies of which had before been unknown to him. A. C. M.

Photo: By permission of the C. P. Railway.

Ocean liners at Vancouver Harbour, British Columbia.



The Dominion of Canada.

Photo: By permission of the C. P. Railway.

Preparing the soil at seed-time in the Moosejaw district of Saskatchewan.

BOOK-KEEPING.—IV

The Sales Book, as its name implies, is used for the purpose of recording transactions where goods have been sold on credit. The various forms it takes according to the needs of different classes of business are truly legion. For instance, it will be obvious that the Sales Book of a colliery company, which deals only in various qualities of coal, will be very different from, and contain much less detail than that of a wholesale provision merchant, who finds it necessary to include many details of the goods sold by him to the retail traders who are his customers.

Although varying in form in accordance with the nature of the particular business, in principle they are the same. In a business in which the invoices are very long, and where it is essential that full particulars should be retained by the vendor, a method commonly adopted is to write the invoices in copying-ink, afterwards making a press copy in a book, in the same way as is done when letters are copied in a letter book. The book which contains copies of invoices made in this way becomes the "Sales Day Book." When invoices are typewritten a carbon copy may be taken, the copies, when filed, representing the Sales Day Book.

The example shown on page 255 illustrates a Sales Book in common use, and it will be seen that it is practically identical in form with the Purchases Day Book.

A Sales Day Book may be used to record merely the date, name of the purchaser, and the amount of each invoice, the details being kept in a press copy-book or in the form of carbon copies of invoices.

Just as the total of the Purchases Day Book must be posted to the Purchases Account in the Ledger, so the total of the Sales Day Book is entered in one sum in the Sales Account. As the goods go out the Sales Account must be credited, thus :—

In the same way the accounts of Eyre, Murdock and Dillon will each be debited with the value of the goods sold to them.

It sometimes happens in business that for one reason or another goods which have been bought are returned by the purchaser. It may be that they have suffered damage in transit; they may not be of the exact quality or shade desired; or they may be found unsuitable for the purpose for which they were intended.

All these causes may or may not be due to inefficiency in the vendor's establishment. Damage in transit may sometimes be the result of carelessness during a busy season on the part of an overworked staff at the Post Office or the railways, but more often perhaps can be traced to bad or inadequate packing.

In any case the seller agrees to the return of the goods, and undertakes to credit the buyer with their value. Such transactions are provided for in book-keeping by **Returns Book.** When goods have been purchased and are afterwards returned they are entered in what is called a **Purchases Returns Book** (sometimes termed a "Returns Outwards Book"), and when goods which have been sold are sent back to the seller he records the transaction in his **Sales Returns Book** (which is sometimes referred to as the "Returns Inwards Book").

Suppose, for example, that when Thomas Ellis receives the goods as recorded in the Sales Book shown in this lesson he finds that through carelessness in packing some portion of the goods is rendered unsaleable. By arrangement with the seller he returns five yards of the worsted and ten yards of the satin. The seller will send to him a "Credit Note" for the amount, and the transaction will be recorded in the Sales Returns Book of the seller as on page 255.

Dr. SALES ACCOUNT *Cr.*

							19.. Feb.	28	By Sundries as per Sales Book	1	136	10	8

The personal accounts of the respective purchasers will be debited thus :—

Dr. THOMAS ELLIS *Cr.*

19.. Feb.	5	To Purchases	1	52	-	-								

SALES RETURNS BOOK 1

19..						£	s.	d.
Feb.	12	THOMAS ELLIS	5 yds. worsted	@	8/-	2	-	-
			10 „ satin	@	11/-	5	10	-
					£	7	10	-

Although these goods have come in, they are not recognised as purchases, but treated as a reduction of the amount of the sales. The Sales Account, therefore, is debited by having the amount posted to it from the Sales Returns Book, thus :—

Dr. SALES ACCOUNT *Cr.*

19..				£	s.	d.	19..				£	s.	d.
Feb.	12	To Returns (T. Ellis)	1	7	10	-	Feb.	28	By Sundries (per Sales Book)	1	136	10	8

As Thomas Ellis has parted with these goods, his transaction must be credited, thus :—

THOMAS ELLIS

19..				£	s.	d.					£	s.	d.
Feb.	5	To Purchases	1	52	-	-	Feb.	12	By Returns	1	7	10	-

SALES BOOK

19..				Rate	Fol.	£	s.	d.	£	s.	d.
Feb.	5		THOMAS ELLIS								
		20	yds. worsted	8/-		8	-	-			
		80	„ satin	11/-		44	-	-			
									52	-	-
„	9		JAMES EYRE								
		90	yds. cotton	1/3		5	12	6			
		500	„ zanilla	1/4		33	6	8			
									38	19	2
„	15		WILLIAM MURDOCK								
		10	yds. tapestry	3/6					1	15	-
„	21		EDWARD DILLON								
		90	yds. worsted	8/-		36	-	-			
		90	„ cotton	1/3		5	12	6			
		4	„ satin	11/-		2	4	-			
									43	16	6
								£	136	10	8

In the books of Thomas Ellis, his Purchases Account will first of all be debited, and when the returns are made he will pass the amount through his Purchases Returns Book, posting the total to the credit of Purchases Account and debiting the personal account of the seller for the value of the goods returned.

The next practical book to which the careful attention of the student is directed is the **Cash Book.** The use of the Cash Book presents few difficulties, and, in its simplest form, it is merely the Ledger Account for cash, written up in a separate book for convenience. All cash received is debited, whilst cash paid out is credited.

The receipts are therefore found on the left (or debit) side, and the payments on the credit side.

A simple form of Cash Book will now be shown, embodying the following transactions :—

19..			£	s.	d.
March	1	Commenced with cash in hand	1,000	–	–
,,	3	Received from James Mills	50	–	–
,,	7	Sold goods for cash..	90	–	–
,,	8	Paid to Francis Thompson ..	100	–	–
,,	9	Bought goods for cash	85	–	–
,,	16	Paid Trade Expenses	8	–	–
,,	18	Received from Eli Wolf	81	–	–
,,	21	Paid Wages	10	–	–
,,	23	Sold goods for cash ..	63	–	–
,,	26	Paid rent	5	–	–

CASH BOOK

RECEIPTS						PAYMENTS					
19..			£	s.	d.	19..				£	s.	d.
March	1	To Capital	1,000	–	–	March	8	By Francis Thompson		100	–	–
,,	3	,, James Mills	50	–	–	,,	9	,, Goods		85	–	–
,,	7	,, Goods	90	–	–	,,	16	,, Trade Exp.		8	–	–
,,	18	,, Eli Wolf	81	–	–	,,	21	,, Wages		10	–	–
,,	23	,, Goods	63	–	–	,,	26	,, Rent		5	–	–
						,,	31	,, Balance	c/d	1,076	–	–
			£	1,284	–	–			£	1,284	–	–
March	31	To Balance	b/d	1,076	–	–						

As it is not possible to pay out more than one receives the debit side (representing the receipts) must always be greater in amount than the credit side, unless the account actually balances. The balance of the Cash Book is necessarily always carried down as a debit balance.

The only items in the above Cash Book which may not be clear are those relating to the sale or purchase of goods for cash. When purchases or sales are cash transactions it is not necessary to record the names of the persons from whom the goods are bought, or to whom they are sold. When the name is not recorded it is looked upon as a ready-money transaction.

Every item on the debit side will be posted to its appropriate account in the Ledger, where it will be placed on the credit side.

In the same way the credit items will be posted, but on the opposite (i.e. the debit) side in the appropriate Ledger accounts.

When a Cash Book is used it is not necessary to open a Cash Account in the Ledger ; but when preparing a Trial Balance the student must remember that the Cash Book balance requires to be treated in the same way as a Ledger Account.

Definition of Terms

A Money Order (M.O.) is an order made by one Post Office to another specified office for the payment of any sum not exceeding £40. The sum is first deposited by the sender, who receives in return the Money Order, which document must be presented by the payee in person or through a Bank to the Office at which it is made payable.

A Postal Order (P.O.) is a document issued by the Post Office for any sum from sixpence by multiples of sixpence up to £1, and also for one guinea. A Postal Order may be cashed at any office which the sender—or, in default of the sender, the payee—selects.

The student has now been introduced to all the books which, in a more or less modified form, could meet the needs of practical work.

In order, however, that he may be in a position to ascertain what to a business man is most important information—namely, the profit or loss during the period of trading—it is necessary to proceed a step farther. The trader invariably wishes to distinguish between his gross and net profit. Gross profit is represented by the balance of the Trading Account after debiting stock at the commencement, together with purchases and purchase expenses, and crediting sales and stock at the end of the trading period. Net profit is gross profit less selling and management expenses.

When the student is able to find the gross and net profit as the result of account-keeping, he will be in a position to answer the questions enumerated in the first Lesson —questions which can only be answered as the result of the application of the principles of double entry. F. H.

WHO PAYS INCOME TAX ?

900,000 people whose income does not exceed £160

443,000 whose income exceeds £160 but not £250

160,000 ..... £400 ..... £500

49,300 ..... £700 ..... £800

35,400 ..... £900 ..... £1,000

91,800 ..... £1,000 ..... £1,500

28,900 ..... £2,000 ..... £2,500

OUR TAXABLE INCOME

Taxable Income of the United Kingdom

£ 1,970,000,000

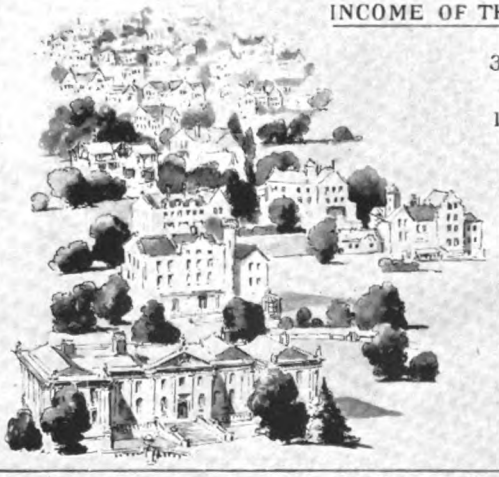
Net Produce of Income Tax	Net Produce of Super Tax
£296,000,000	£12,300,000

THE STORY OF ABATEMENTS

1590,000 people	£130	£160
290,000 whose	£160 but	£200
50,000 income	£200 not	£250
10,000 exceeds	£250	£300

are entirely relieved of Income Tax through the Abatements & Allowances

INCOME OF THOSE WHO PAY SUPER TAX



36,535	people pay on incomes exceeding	£2,500	but not £5,000
13,974	.....	£5,000	£10,000
1,749	.....	£15,000	£20,000
550	.....	£25,000	£30,000
257	.....	£40,000	£50,000
122	.....	£75,000	£100,000
148	people have Incomes exceeding		£100,000

TOTAL OF INCOMES

Total Number of Incomes Chargeable	3,346,900
Incomes relieved through Abatements	1,940,000
Total Number of Incomes	5,286,900
Total of Incomes paying Super Tax	59,100
Grand Total of Incomes	5,346,000

BRITAIN'S MAIN SOURCE OF REVENUE.

Income Tax, originally purely a war tax, was first levied in 1798. It was repealed in 1816, but re-imposed in 1842, since when it has been continued annually. It was 1s. 4d. in the £ in 1855, 2d. in the £ in 1874, and in 1919 graduated from 2s. 3d. to 6s. in the £, according to income, large incomes being also subject to a super-tax.

Continued from page 203.

ENGLISH LANGUAGE AND LITERATURE:

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FROM GEOFFREY CHAUCER TO EDMUND SPENSER

BEFORE considering the writings of Edmund Spenser, something must be said about the extraordinary influence on his generation of Sir Philip Sidney—the most remarkable man of that remarkable era.

It has been asserted that Spenser's *Faery Queen* was Poetry's farewell to the age of chivalry. If so, one of the equipments of Spenser for composing that farewell was that he knew the man who, though outside the age of chivalry, represented it, perhaps, more perfectly than any man of any time. Sidney was only in his thirty-second year when he died, but fame had come to him from many sources.

Sir Philip Sidney

"A very perfect gentle knight," he was known throughout Europe as a diplomat, a scholar, and a man of irresistible personal charm. It was the direct influence on men of what Spenser called "that most heroic spirit" that was phenomenal. He seemed to live always in the very atmosphere of knightliness. What King Arthur was fabled to be Sidney really was. It could be seen in all he did, and advised, and wrote, and in what all men thought of him. His character largely formed the ideals of Spenser, and was reflected in everything Spenser wrote.

Sidney was born in 1554, at Penshurst in Kent, son of Sir Henry Sidney, lord deputy of Ireland. After an education at Shrewsbury and Oxford, Philip travelled, and studied widely on the Continent, where kings treated him as an equal. At home as a Court favourite, the vanity of the Queen did not prevent him from speaking his mind freely.

The advice he is known to have given strikes the modern observer as singularly wise, but he often lacked the employment his statesmanship deserved. A chance shot in a skirmish in Flanders put an end to a life that promised the highest distinction alike in the spheres of thought and of affairs.

Sidney's influence on literature was felt through his sonnets, *Astrophel and Stella*, which re-established the sonnet after a decline since the days of Wyatt and Surrey; through his prose writings in the romance *Arcadia*, and in the *Defence of Poesy*—the first English literary criticism; and in the fact that he, "the glass of fashion and the mould of form," was proud to write, and gave authorship a standing it had never attained before in this country.

Edmund Spenser was born in London, in 1552, of a North Lancashire family, which claimed kinship with the Spencers of Althorp—the family of the modern Earl. He was educated at the Merchant Taylors' School, his father being engaged probably in the cloth trade. Later, he made some reputation at Cambridge as a scholar and poet, and gained the friendship of a worthy but pedantic don named Gabriel Harvey, whose literary influence was not good.

Spenser's Early Work

Harvey wished to torture English into the poetical forms of the classical tongues, in defiance of the natural structure of the language, and when Spenser, led aright by his fine ear for the melody of words, found suitable expression for his fancies through the stanza he invented for his *Faery Queen*, a measure now called by his name, Harvey slighted the poem, and possibly delayed its publication.

After leaving the University, Spenser lived a year or two in the North, writing poems, some of which are now lost, and

THE SHEPHERD'S CALENDAR

nourishing an unrequited poetic passion for one Rosalind—an experience that coloured much of his early work.

Returning to the South, by the advice of Gabriel Harvey, he became a member of the household of the Queen's favourite, the Earl of Leicester, one of Harvey's friends, and uncle of Philip Sidney. The young poets thus thrown together were soon great friends.

The Faery Queen

On the full tide of this intellectual companionship Spenser was swept forward to sudden fame. In the years 1579–80 he completed his poem *The Shepherd's Calendar*, and began his *Faery Queen*. *The Shepherd's Calendar*, published in December, 1579, at once became popular, and with one consent Spenser's contemporaries gave him the garland as the choicest poet of his day.

In July, 1580, the poet was appointed secretary to the Lord Deputy in Ireland. Then began an exile that, with holiday intervals, lasted the rest of his life. After nearly nine years of official work Spenser was visited in Ireland by Sir Walter Raleigh, who induced him to return with him to England. The poet arrived in London with the manuscript of three books of his *Faery Queen*, out of the twelve books projected.

They were at once printed and more than repeated the success of *The Shepherd's Calendar*. The Queen, to whom the poem was dedicated, awarded the poet a pension of fifty pounds a year; but he received no preferment that saved him from exile.

Presently he returned to Ireland, and at once wrote *Colin Clout's Come Home Again*, telling of his visit to the Court with Raleigh, and his experiences in London. The poem includes a reference to Shakespeare, who was a lad of fifteen at Stratford on Avon when *The Shepherd's Calendar* appeared, but at the time of Spenser's return from Ireland had been four or five years in London.

The success of the *Faery Queen* was followed, before the end of the year, by a miscellaneous volume entitled *Complaints*, most of the poems being early compositions.

On his return to Ireland Spenser fell in love and married, at the age of forty-two; his courtship being commemorated in his *Amoretti* sonnets, and his marriage in the beautiful *Epithalamion*.

Late in 1595 Spenser again visited London, and stayed there during the whole of 1596 and part of 1597, his objects being to publish a second instalment of three books of the *Faery Queen*, and to secure preferment at home, for though he had been rewarded in Ireland with large grants of land—three thousand acres—for his official services, long residence away from his friends and in the neighbourhood of constant turmoil was distasteful and disappointing.

The publication of the fourth, fifth, and sixth books of the *Faery Queen* in 1596 confirmed the poet in his position as the accepted poets' laureate of that age.*

*It may be mentioned for comparison that this was the year when Shakespeare wrote *The Merchant of Venice*. *A Midsummer Night's Dream* had been written about two years earlier. The great Shakespearean tragedies belong to a future that then was from five to ten years distant.

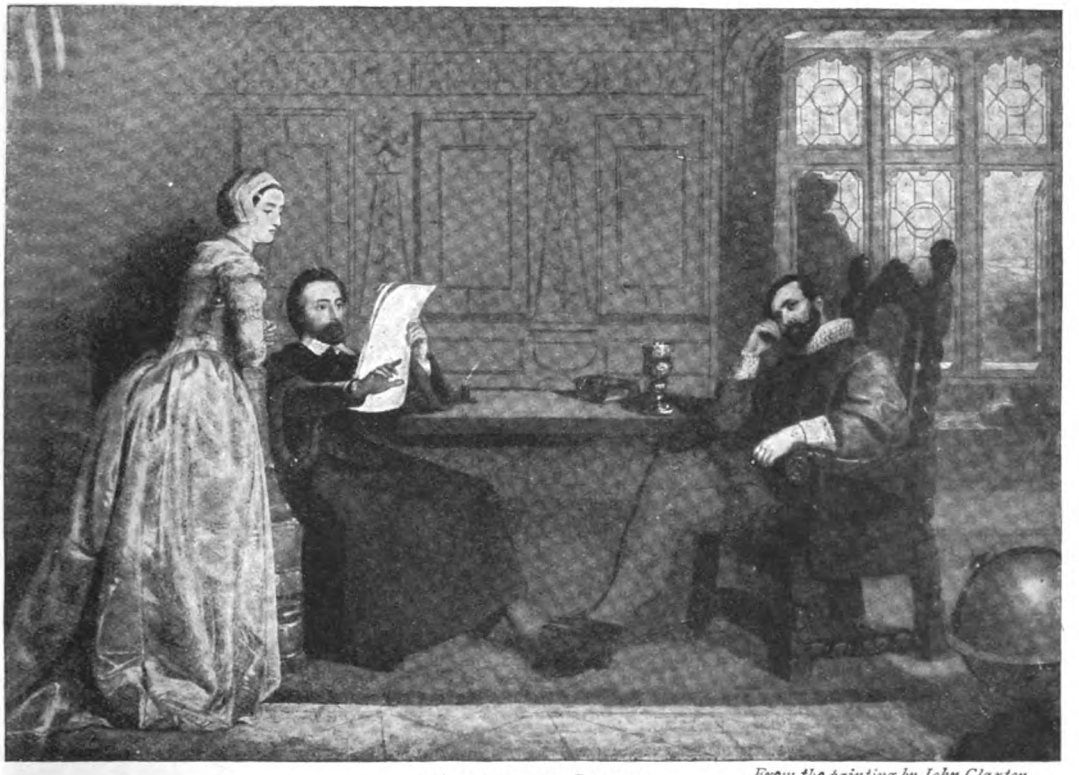
THE SHEPHERD'S CALENDAR

From the first edition, published by Spenser under the pseudonym of "Immerito" in 1579.

While he was in town, towards the end of 1596, Spenser printed his *Hymns of Love and Beauty*, his *Prothalamion*, in honour of the marriage of the daughters of the Earl of Worcester, and his *Astrophel*, lamenting Sir Philip Sidney. These were the last writings published during his lifetime. Disappointed, and in failing health, the poet returned to Ireland in 1597.

Burleigh, who probably had been the stumbling block in the path of the poet's worldly advancement (for Spenser was friendly with his rival Leicester), was now dead, and it seemed likely that long-deferred preferment would follow. Indeed, in 1598 Spenser was appointed Sheriff of Cork; but the autumn brought an insurrection of exceptional violence that swept the English out of Munster, and the poet and his family escaped with difficulty when his castle of Kilcolman was stormed, sacked, and burned. At the close of the year he was sent over to England with dispatches for the Government, but, worn out by his labours and anxieties, he was taken ill, and on January 16, 1599, died at an inn in Westminster.

There is much doubt as to the exact circumstances of the last few months and weeks of the poet's life. Tradition makes one of his children perish amid the ruins of the Irish home, and even suggests poverty at last to the extent of "lack of bread"; but Spenser was the darling of the poets, and poets love to cherish the thought that the world "requites them unkindly." Spenser had been lonely rather than poor, and he had powerful friends and devoted admirers. Essex paid for his funeral in the Abbey; the Queen ordered a tomb for him; and the poets of his day, according to Camden (who was Clarenceux King of Arms at the time, and had recently resigned the headmastership of Westminster School), mourned his loss in elegies which they threw, with their pens, into his grave.



THE FAERY QUEEN *From the painting by John Claxton.*

Edmund Spenser reading to Sir Walter Raleigh his great poem, which was first published in 1590.

The Shepherd's Calendar is a series of pastoral poems, one for each month of the year, written in varying metres, and introducing, in allegorical forms, a wide variety of subjects. In it, as Spenser's college friend Edward Kirke said in his appended comments, the poet was testing his pinions for a higher flight. But the place of the *Calendar* in the story of our literature is conspicuous.

Leaving aside for the moment the poet's

greatest work, brief mention must be made of a series of poems, scattered in composition throughout his writing life, which tell us of his personal affections, hopes, disappointments, and throw light on the age. It is a curious fact that Spenser, who evidently knew Shakespeare, did not realise how wonderful was the intellectual activity of his day. Thus, in *A Midsummer Night's Dream* the dramatist quite fitly describes the poet's *Tears of the Muses*—

> The thrice three Muses mourning for the death
> Of Learning, late deceased in beggary.

Yet, in spite of Spenser's *Tears*, the nine Muses have never found more glorious expression than from other pens during his life.

In *Mother Hubberd's Tale*, published as part of the *Complaints*, we have the poet's bitter experience of hope of suitable preferment long deferred. The references to Raleigh in *Colin Clout's Come Home Again* are delightful in their joyous appreciation, and admiration of Sidney flowed continually from his pen—

> For all his mind on honour fixéd is.

Amoretti Sonnets

And then his love! No other poet has ever placed human love on such a lofty pedestal of purity, for whole-hearted worship, as he, in his *Amoretti* sonnets and *Epithalamion*—

> Ye tradeful merchants that, with weary toil
> Do seek most precious things to make your gain,
> And both the Indies of their treasure spoil,
> What needeth you to seek so far in vain?
> For lo, my love doth in herself contain
> All this world's riches that may far be found:
> If sapphires, lo, her eyes be sapphires plain;
> If rubies, lo, her lips be rubies sound;
> If pearls, her teeth be pearls, both pure and round;
> If ivory, her forehead ivory weene;
> If gold, her locks are finest gold on ground;
> If silver, her fair hands are silver sheen:
> But that which fairest is, and few bel old,
> Her mind, adorned with virtues manifold.

This lofty ideality is an atmosphere that pervades the whole of Spenser's great poem the *Faery Queen*. Considered as a planned whole, the *Faery Queen*, in the fragmentary form it has reached us, is a maze that no one can simplify; and if the other six books had been written, or preserved, the intricacy would probably have been greater, not less.

For Spenser had no constructional power, no dramatic instinct. He set out to suggest a perfect character, and to that end, as he explained in a letter to Raleigh, planned twelve knights who should represent the twelve chief virtues, and seek adventures in overcoming the vices opposed to those virtues. But the knights and their opponents also represented real persons, or causes, active in Elizabeth's reign. The result is that ideality and reality, masquerading in allegory, quickly become confused, and the task of interpretation is impossibly complex.

When we know that the poet has made a fairyland of the moral world, with Holiness, Temperance, Chastity, etc., as its knightly heroes, and Error, Despair, Licence, etc., as its evil apparitions, we can understand enough for immediate guidance, and go on our way with him, charmed by the beauty of his pictures, and lulled into dreamy ease by the melody of his voice.

Spenser's Influence on Poetry

For the special purpose of his *Faery Queen* Spenser invented a new measure, by adding to the eight-line verse of five beats a ninth line of six beats. To many ears the gentle reverberatory roll of this last Alexandrine line suits peculiarly the spirit of—

> Sweet Spenser, moving through his clouded heaven
> With the moon's beauty and the moon's soft pace.

Its echoes can be heard along our literature ever since, in Milton, Thomson, Burns, Keats, Shelley, and Byron; but no poet has wrought into the Spenserian stanza more haunting harmonies than its inventor. Take the description, in the first canto of the first book, of the deep sleep of the Red Cross knight—

> And more to lull him in his slumber soft,
> A trickling stream from high rock tumbling down,
> And ever drizzling rain upon the loft,
> Mixed with the murmuring wind, much like the sowne
> Of swarming bees, did cast him in a swowne.
> No other noise, nor people's troublous cries,
> As still are wont t'annoy the walléd town,
> Might there be heard; but careless Quiet lies
> Wrapt in eternal silence far from enemies.

Whatever his subject may be, Spenser rises to its full height in poetic rapture, and sustains the music of his verse like the sound of many waters. By him was mediæval heroism shorn of all its grossness; and with him there came into English literature a clearer, purer, sweeter, loftier strain than had been heard before. J. D.

THE ENGLISH LANGUAGE.—III

WHILE in general the aim of a good writer is to express his thoughts as simply and clearly as possible, it does not follow that he will choose the first or the simplest words that come to his mind. There is a rule of fitness as well as a rule of simplicity in composition. Think of Gibbon's *Decline and Fall* written in the style of Mark Twain, or *The Biglow Papers* in the diction of *Paradise Lost!* A text-book of Science has to be exact and lucid above all things, whereas a work of art, such as a novel, an essay or a poem, would be killed by such bald simplicity of language.

Two forms of error in the choice of words may be recognised: those due to pedantry and those due to barbarism.

Pedantry and Colloquialisms

Pedantry means essentially a display of learning in the wrong place, i.e. where it is not adapted either to the subject or to the reader. Thus, in a general composition, intended for unscientific readers, the use of scientific terms, such as *myopia, pia mater, epicycle, azimuth*—and often also of general terms that have scientific associations, such as *affinity, induction, harmonic, function*—is more likely to produce confusion than either pleasure or enlightenment. Similarly, the use of allusion, which would imply more classical or literary knowledge than the reader is likely to possess, is pedantic. This does not rule out of ordinary composition such convenient words as *electrify, environment, tangent*, or such familiar allusions as those to Hercules or Pandora, the Rubicon or Ichabod. It is ostentation that is objectionable, the inappropriate dragging-in of the writer's personal, special knowledge.

Associated with pedantry is **periphrasis** or circumlocution, the expression of a simple idea in a roundabout way, using many words instead of a few direct ones. In its proper use, periphrasis enables us to avoid the ambiguity which often arises from a too severe brevity, and no one would wish the Essays of Charles Lamb recast into an exact and straightforward style. Its improper use leads to prolixity and verbosity, the bad habit of attempting to hide the nakedness of thought by a multitude of words.

Barbarisms are those words or expressions which offend against the law of taste. Many words are allowable in ordinary speech, but are inappropriate in writing; such colloquialisms as *won't, fiver, lingo, quod*, and abbreviations like *-phone, pub-*, come under this heading. Akin to them is slang, a body of often expressive words usually employed by one class only. The objection to slang words like *swank, tin* (= money), *swag, flapper* lies in their vulgar or restricted application; to many persons they would be unintelligible, and their invariable effect is to degrade the tone of writing. Nevertheless, slangy words and phrases often pass into current use as part of the idioms or peculiarities of language. To *boycott* must now be regarded as good English, and a *swell* is recognisable in any company: so he may *cut a dash* without offence. Of the large volume of slang produced by the Great War, probably very little will survive, except among the soldiers. *Gone west*, however, and *stunt* have found their way into literature and meet real needs.

We may here counsel also the avoidance of the hackneyed word or phrase—the word which was once smart but has become worn out by over-use. The *clean sheet*, the *psychological moment*, *terminological inexactitude* are examples. The reader of the second-rate newspaper is weary of such expressions. The ordinary writer will also be wary with **neologisms** or new words, especially new coinages which are perhaps peculiar to a particular writer or which may have come from America.

Spelling of English

Before the invention of printing there was no clear standard of spelling in English. In O.E. the spelling seems to have been largely phonetic, each vowel or diphthong corresponding to a definite sound. But the French influx upset this desirable state of affairs, with the result that to-day the same sound is not always represented by the same symbol (*pain, pane, rein*); nor does the same symbol always denote the same sound (*broad, oat, oasis*). There is consequently much confusion of spelling in Tudor English; and, though usage has fixed a standard to-day, there still survives a difficult and irregular system which makes English spelling no easy matter.

Efforts to simplify it have met with little favour in England, though something has been done in America; it is necessary to conform to the custom of our best writers, which is recorded in the standard spellings of our dictionaries. It is not wise to use *favor, labor, traveler, program*, as a few writers do. Good spelling is the result of observation and care during reading.

(i) Words ending in a single consonant double that consonant when a suffix be-

ginning with a vowel is added, except when the accent does not fall on the final syllable ; e.g. plan, plan*ned*, plan*ning* ; refer, refer*ring*, refer*ence* ; offer, offer*ed*. Exceptions to this rule are to be noted in quarrelling, traveller.

(ii) Words ending in **-e** drop the **-e** before a vowel (except when it is **a** or **o** immediately preceded by **c** or **g**) : e.g. combin*ing*, pur-su*ance*, sens*ory*, courage*ous*, irreplace*able*, seiz*ure*. The **-e** is also retained in dy*e*ing, sing*e*ing, sho*e*ing, ho*e*ing. Words ending in **-ie** change **ie** into **y** before **-ing** : e.g. d*y*ing, t*y*ing. Before a suffix beginning with a consonant the final **-e** is usually retained : lon*e*ly, encouragement, concise*n*ess. But note the following exceptions : judgment, acknowledgment, abridgment, development, awful, truly, argument.

(iii) Final **-y**, preceded by a consonant, is changed into **-i** before suffixes beginning with a vowel, except **-ing** : marr*i*age, read*i*er, def*i*ed. Also before **-ly, -ness, -ment,** etc. : merr*i*ly, lonel*i*ness, accompan*i*ment.

(iv) Use **i** before **e**, except after **c** : rec*ei*ve, rec*ei*pt, c*ei*ling, s*ie*ge, n*ie*ce, rel*ie*f, br*ie*f. But *N.B.* s*ei*ze, and words with the sound heard in rein, skein.

(v) A prefix or suffix ending in **ll** usually drops an **l** : *al*ways, faith*ful*, with*al*, un*til*, ful*fil*.

Subject and Predicate

Words are connected together, according to the rules of syntax, into sentences, through which they are made to express thoughts. A sentence is the expression of a complete thought in words. In the making of a sentence we have to consider not merely the correct usage of the words, but their correct form and arrangement, which is what is meant by syntax. Everyone would recognise something wrong in the sentence—" I have the boy punished, because he my book stolen has " ; the syntax is German, not English.

A simple sentence is a sentence which expresses one thought only : e.g. " The book is lying on the table." In this sentence, as in all sentences, we distinguish two parts, viz. the Subject and the Predicate. By the subject we mean the person or thing about which the statement is made ; the predicate consists of the statement which is made about the subject.

EXERCISE : Pick out a few simple sentences from any book, and analyse them thus :—

Subject	*Predicate*
The book	is lying on the table
Birds of a feather	flock together.
Neither of those men	is fit for his position.
They	asked me a question.

The essential word in the subject of a sentence is a **noun,** or its equivalent, a **pronoun.** A noun is the name of anything, and a pronoun is a word used instead of a noun to prevent its repetition (*his, they*). In the predicate, the essential word is the **verb** which expresses an action or state (*is lying*). But in order to form a predicate, a verb must be *finite*, i.e. it must express the action completely. The words, " The book lying on the table," do not make a sentence, because the verb *lying* is not finite : it denotes an action which is not connected definitely with the book in person and number (*see* below). Moreover, there are certain verbs (to *be*, to *become*) which ordinarily convey no meaning by themselves, but need what is called a complement before a complete predicate is made : e.g. in the sentence, " The boy is a dunce," *a dunce* is the complement : " The boy is " does not make a statement at all.

Analysing Sentences

The subject of a sentence consists, then, in the strict sense, of a noun or pronoun ; but these words are often enlarged or qualified by adjuncts. The adjunct may be a single word, or a group of words, or even a sentence, as in the three examples following :—

(i) The *useful* book is lying on the table.
(ii) The book *with the red cover* is lying on the table.
(iii) The book *which has a red cover* is lying on the table.

The predicate also consists in most cases of something more than the original verb. In the sentences above, the group of words *on the table* is an adjunct or extension of the verb *is lying*. Moreover, there are many verbs in which the action may pass over from the subject to another noun or pronoun which is then known as the **object :** e.g. in the sentence, " The boy eats an apple," the action passes from the subject *boy* over to the object *apple*.

Thus for the complete analysis of a simple sentence we first seek for the subject proper and the verb which is the essential part of the predicate ; then pick out the adjuncts and tabulate as follows :—

Example.—The thoughtful boy won the prize easily.

SUBJECT.—The thoughtful boy.
Subject proper—boy.
Adjuncts of Subject—the thoughtful.
PREDICATE.—Won the prize easily.
Verb—won.
Extension of Verb—easily.
Object of Verb—the prize.

Confusion is common in ordinary speech between the *phrase* and the *sentence*, but they must be clearly distinguished in grammar. A phrase does not express a complete thought: it is a group of words which act together as if they were a single one, denoting one idea. Frequently a compound word can be thought of which would replace a phrase: e.g. the *red-coated* girl = the girl *in the red coat*. This cannot always be done. A phrase is usually an adjunct of a noun or a verb.

EXERCISE: Pick out the phrases from the following sentence, and explain their relation as below:—The book lying on the table was found in your room on Tuesday.

Phrase	*Adjunct to*
lying on the table	The noun, book.
on the table	The verb, lying.
in your room	The verb, was found.
on Tuesday	The verb, was found.

The first rule of English syntax is the **rule of concord**, which says that the finite verb of the predicate must agree in number and person with the noun or pronoun which forms the subject. The mistakes in the following sentences will explain what this means:—

(i) The men is at home.
(ii) The boy am here.

In (i) *is* must be wrong because the plural form (*are*) is required, to agree with *men*. In (ii) *am* is the form for the first person, whereas the subject-word *boy* is in the third person.

Simple as this rule is, it is often broken, even by reputable writers, who have lost sight of the true subject, as is shown in the following examples:—

(iii) *Each* of his friends are with him [is].
(iv) *Neither* of them are here [is].
(v) A *crowd* of idle men and women were standing by [was].
(vi) *John*, and I would add his friend Tom, are good men [is a good man].
(vii) *Every one* but those friends of yours have come [has].

WAR AND LETTERS. *Photo: Illustrations Bureau.*

Leaders of the Allied Forces as Doctors of Civil Law. Leaving the Sheldonian Theatre, Oxford, having received their degrees, June, 1919. Marshal Joffre and Gen. Pershing (in the foreground) are followed by Field Marshal Haig, Admiral Beatty, and Sir Henry Wilson.

(viii) The book and the paper *which* lies in my drawer must not be disturbed [lie: unless *which* stands for the paper only].
(ix) An immense *amount* of progress and advantage result [results].
(x) The *desire* of all men are high wages and comfort [is].

Associated with this type of carelessness is that breach of concord which is due to the inexact use of plural pronouns to stand for singular nouns, as in the following examples:

(xi) Each of them can do it *themselves* [himself].
(xii) One often leaves *their* tools at home [his, her, one's].
(xiii) Everybody cannot use *their* brains properly [his].
(xiv) The duty of Germany is to take *their* armies out of Belgium [her].

Nouns are classified as Proper, Common, Abstract, Collective or Material according to their nature: *John*, *book*, *goodness*, *crew*, *water* are examples which suggest the definitions of the respective classes. It must be remembered, however, that the classification refers to the use of the noun, and is not inherent in the word itself.

(i) I am wearing a *Burberry*. [Proper noun as common.]
(ii) The *iron* is on the stove. [Material noun as common.]
(iii) He did me a *kindness*. [Abstract as common.]
(iv) *Parliament* decided to act. [Collective as proper.]

The formation of the plural in English nouns is generally effected by means of the inflection *-s* or *-es*, the latter being used only where it is necessary in order to make the added suffix effective, as in *foxes*, *asses*, etc. The *-es* is also used—(*a*) After *y* preceded by a consonant, the *y* being first changed into *i*, as in *stories*, *fancies*, *soliloquies* (qu = kw). If a vowel precedes the *-y*, the usual method is followed, as in *essays*, *storeys*, *donkeys*, *alloys*, etc. (*b*) After *f*, the *f* being changed into *v*: *loaves*, *wharves*; but this does not always happen: *chiefs*, *roofs*, *hoofs*, *safes* and many others follow the usual rule. (*c*) After *o*, preceded by a consonant, as in *heroes*, *potatoes*, *mulattoes*. Again, however, there are many exceptions, mainly words of Italian origin and comparatively recent introduction: *pianos*, *solos*, *cantos*, *virtuosos*, *grottos*, *provisos*.

Old English Plurals

Old English plurals survive in *oxen*, *brethren*, *children*, *teeth*, *feet*, *geese*, *mice*, *lice*, *men*, *women*, and in the unchanged plurals of *deer*, *sheep*, *salmon*, *score*, *stone* (used as a weight), etc. Both *fish* and *fishes* are used as the plural of *fish*, but the latter form refers to the fishes as individuals, not as a collective whole.

Foreign nouns, at least so long as they are distinguished as such, usually retain their foreign plural forms; though when a word has become really at home in English, the habit of using the English form of the plural gradually develops, e.g. *formulas* is as often found as the Latin *formulæ*. Examples of foreign plurals are:—*French*, tableaux, portmanteaux; *Latin*, formulæ, radii, genii, genera (from *genus*), agenda, axes, indices, series, foramina, apparatus; *Greek*, criteria, phenomena, crises; *Italian*, banditti, condottieri; *Hebrew*, cherubim. But we also have prospectuses, omnibuses—Latin words following the English plan.

In compound nouns the plural sign is given to the noun which is the chief component of the compound, and is not usually added to the descriptive half. Thus we have *mothers-in-law*, *maid-servants*, *Lords-Lieutenant*, *hangers-on*; and *menservants*, *Lords Justices*. Common sense is usually a safe guide.

It should be noted that certain nouns which are plural in appearance are singular in sense and require a singular verb: such are *news*, *tidings*, *innings*, *means*, *pains*. These must be distinguished from those plural nouns which have no singular:—*scissors*, *shears*, *bellows*, *gallows* require a plural verb.

Use of the Possessive

Case means the relation which exists between the noun or pronoun and the rest of the sentence. The *nominative* case is that of the subject; the *accusative*, sometimes called the objective, is that of the object and is used after all prepositions in English. Except in the pronouns, there is no separate inflection for the accusative case in English. The *genitive* (or possessive) case denotes the possessor, and is expressed by the inflection *'s* in the singular, and by a simple apostrophe after plurals in *s*. Thus:—*John's*, *Charles's*, *Fox's*, *men's*, *cows'*. In the plural we often use the periphrasis with *of* instead of the true possessive: we say rather *the food of cows* than *cows' food*. This procedure is often followed in the case of noun-phrases: when the inflection is used, it is better to append it to the last word of the phrase than to aim at pedantic accuracy:—*the head of the school's record* or *the record of the head of the school* are both idiomatic; so *John the baker's wife* is better than the strictly accurate *John's the baker's wife* or *John's wife, the baker*.

Mistakes in case arise frequently in pronouns which have the special accusative forms—*me*, *us*, *him*, *her*, *them*, *whom*.

(*a*) Pronouns acting as the complement of a sentence must be in the nominative: e.g. "That was me" should be "That was I."

(*b*) After prepositions, the accusative must always be used. "Between you and I" will not do.

(*c*) *Than* and *as* are not prepositions, and the case following them must be regulated by the meaning. Thus (i) and (ii) do not mean what the writer intended to say:—

(i) You like work better than *me* [I].
(ii) I do not like work so well as *her* [she].

As they stand these sentences really mean—

(i) You like work better than you like me.
(ii) I do not like work so well as I like her.

E. W. E.

Continued from page 208.

HISTORY:

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THE TEUTONIC INVASIONS

THE year 476 marked the final dismemberment of the Western Empire, for, acting on the instructions of Odoacer, the Senate officially signified to Zeno, the Emperor of the East, that it had been resolved to bring the Imperial succession in Italy to an end, and to reunite the whole Roman world under the nominal control of the Emperor at Constantinople.

Zeno approved this resolution, also—of necessity—the rider which accompanied it to the effect that Odoacer should be the Emperor's first viceroy in the West. Thus the Western Empire, the cradle of civilisation, definitely ceased to exist.

But there was no break, it must be remembered, in the continuity of the Empire. The barbarian chiefs, while availing themselves of the weaknesses of Imperial rule, fully appreciated the merits and advantages of Roman civilisation, which they were careful to preserve. The Empire, therefore, still went on, in the West no less than in the East—a convenient fiction linking up ancient with modern history—until at last on the ruins of the old Empire there arose in the West a new empire purely Teuton in character, but which, none the less, also was styled Roman.

Birth of Modern Europe

The disruption of the Western Empire and the birth of the nations of modern Europe were directly coincident. Indeed, while the ancient dominion of Rome was hastening to its extinction, new dominions were arising in almost every part of the Continent.

In 410, it will be remembered, the Visigoths, under the leadership of Alaric's successor, Athaulf—a name later Latinised into Adolphus—made peace with Rome, and set out from Italy to seek their fortune in Spain. There, during the course of the next few years, they established what was really the first of the independent kingdoms of modern Europe.

Their kingdom originally was not restricted to the land we now call Spain; it also included Aquitaine—that is to say, the south-west quarter of Gaul, the fertile territory bounded by the Pyrenees, the Rhone, and the Loire. And by the latter part of the fifth century the Visigoths had become undoubtedly the most powerful people in Western Europe.

Clovis, King of the Franks

Meanwhile, two other Teutonic tribes—the Burgundians and the Franks—had also begun to mark out settlements within the Empire. The Burgundians settled in south-east Gaul; whilst towards the end of the fifth century the Franks, who had already established themselves along the lower Rhine from Cologne to the North Sea, began also to spread westward, and, under their great king, Clovis (a name later corrupted into Louis), made themselves masters of the whole country north of the Loire.

At this time Clovis was a pagan. But in 496 he became involved in a great struggle with the Alemanni, a Teutonic people dwelling on the Middle Rhine; and in his final battle with them, finding himself hard pressed, he offered—in obedience to the wishes of his wife, who was the daughter of a Christian Burgundian chief—to become a Christian if victory should be his.

Victory was his; and Clovis in due course accepted the Christian faith. He was baptised at Rheims in 496, and, unlike other barbarian chiefs who, almost without exception, professed the Arian heresy, was received into the orthodox church. This gave him much influence with the Papacy, and he was saluted by Anastasius, the then Bishop of Rome, as "the Most Christian King"—a title of honour carefully preserved by the subsequent sovereigns of France.

Four years later, in 500, Clovis gained a decisive victory over the Burgundians, and annexed their territory. Then he advanced against the Visigoths in Aquitaine, and be-

fore his death in 511 had succeeded in uniting the whole of Gaul into a single kingdom under his rule.

The Teutonic invaders who settled in Italy, Spain and Gaul, though wild, unlettered barbarians, were not mere conquerors bent only on destruction. They had dwelt on the outskirts of the Empire long enough to appreciate the advantages of civilisation; and instead of trying to exterminate the Roman inhabitants of the territories which they reduced, they freely allowed themselves to be absorbed among them. Thus the Teuton and Latin races mingled; and while the conquered gained in virility from the conquerors, the conquerors adopted many of the laws and customs and much of the language of the conquered.

Latin, of course, was the language spoken by the Romans; and it was the mixture of the Latin tongue with that of the Teutons which gave rise to the so-called Romance languages, the languages spoken, that is to say, in Spain, France, and Italy—and, incidentally, also in Roumania, which is the old Roman province of Dacia—and which only gradually became distinct from one another.

Vandals' Brief Rule

In addition to the Visigoths, the Burgundians, and the Franks, there are three other important Teutonic tribes whose invasions into the Western Empire during this period must be considered—the Vandals, the Ostrogoths or East Goths, and the Lombards. The migrations of the Angles, the Saxons, and the Jutes can better be dealt with when we come to consider the early history of Britain.

The Vandals settled in Africa during the early part of the fifth century, and there founded a kingdom with Carthage as its capital. Now Africa was probably the most highly civilised of all the old Roman provinces. The Vandals, therefore, had an exceptional opportunity of becoming a really strong, progressive people. But, unfortunately for themselves, they were rabid Arians, fanatically intolerant of the orthodox faith; and by their cruel persecutions they utterly alienated the Romans from themselves. As conquerors, therefore, the Vandals gained nothing from the conquered; and their kingdom was destined to last but a while.

The power of the Ostrogoths also proved transient. This people, which for a long time past had been settled on the Lower Danube, came into prominence in 489 when their king, Theodoric, secured a commission from the Emperor Zeno to overthrow Odoacer and so restore Italy directly to the allegiance of the Empire.

Theodoric, who had real genius for war, speedily expelled Odoacer; but then, so far from restoring Italy to the Empire, made himself more powerful than Odoacer had ever been, and ruled to all intents and purposes as a king from 493 to 526. He brought the whole of his tribe-men, women, and children into Italy, and was, as Dean Church has observed, "the first of the Teutonic conquerors who attempted to carry out the idea not merely of administering a conquest, but of founding and governing a state." A born leader, he was also a statesman.

Italy under Theodoric

The years of his rule were the happiest and most prosperous that Italy had enjoyed, or was to enjoy, for a very long time. Odoacer had never risen above the level of a successful soldier. Theodoric, on the other hand—the one really great man his tribe produced—possessed all the qualities of a statesman, and during his reign displayed a firmness, moderation, and sense of wisdom remarkable in a barbarian chief.

"The life of Theodoric," wrote the historian Gibbon, "represents the rare and meritorious example of a barbarian who sheathed his sword in the pride of victory and the vigour of his age. A reign of thirty-three years was consecrated to the duties of civil government, and the hostilities in which he was sometimes involved were speedily terminated by the conduct of his lieutenants, the discipline of his troops, the arms of his allies, and even by the terror of his name."

From his capital of Ravenna, Theodoric ruled his dominions with the established machinery of the Empire to which he had in fact succeeded. With the laws and customs of the land he made no attempt to interfere, and he left the civil administration entirely in the hands of Italians. Thus, although the latter found themselves under the sceptre of an unlettered barbarian, their condition was immeasurably better than it had been during many years of the later Empire.

Theodoric, again, although himself an Arian, treated orthodox Catholics with all respect and fairness. Indeed, in religious matters he showed a toleration which equalled the justice of his secular administration. Italy, therefore, thrived and prospered under his rule; and it would have been well for

THE MOSQUE OF ST. SOPHIA, CONSTANTINOPLE,

designed by the Emperor Justinian, was completed in 537, and remained a Christian place of worship until 1453, when Constantinople fell into the hands of the Turks. The sign of the Crescent was then substituted for the Cross.

the country had the power of the East Goths endured.

But this was not to be. In 526 Theodoric died, leaving behind no worthy heir upon whom his mantle might fall; and it so happened that at about this same time there ascended the Imperial throne at Constantinople one of the ablest and most resolute of all the Emperors—the great Justinian.

Justinian it was who built the noble church of St. Sophia at Constantinople. Justinian it was who codified the laws of Rome, tabulating, revising, and bringing within a practicable compass the mass of often contradictory legal matter which previously had existed in thousands of volumes.

The church of St. Sophia still stands—though nowadays it is no longer a place of Christian worship, but a Turkish mosque—and the Civil Law of Justinian still exercises a living influence over the social state of many countries. Indeed, it forms the groundwork of the jurisprudence of almost the whole continent of Europe.

Justinian Expels the Teuton

Now, as Emperor, Justinian conceived of the laudable design of regaining for the Empire the dominions which had passed into the hands of the triumphant Goths and Franks and Vandals. The Franks, however, were too far distant and too powerful to be easy subjects for immediate attack. The Emperor, therefore, first turned his attention to the Vandals and the Goths—especially the East Goths, for they held Italy, and Italy naturally was particularly dear to one who claimed to be a successor of Augustus.

Justinian himself was not a general of the first rank, but he was fortunate enough to be able to claim the services of a soldier of really outstanding merit—Belisarius, who, as Dr. Freeman had observed, "was perhaps the greatest commander that ever lived, as he did the greatest things with the smallest means."

Under Belisarius the Roman legions regained something of their old reputation for discipline and fighting qualities, and by 534 had utterly reduced the Vandal kingdom in northern Africa. Belisarius then landed with his army in Italy.

But the power of the Goths proved far less easy to destroy than that of the Vandals. The struggle in Italy was fierce, prolonged, and sanguinary. But at last, in 553, the Goths were so completely defeated by Belisarius' successor, Narses, that they agreed to depart from Italy with all their movable possessions. What became of them ultimately no one knows. All that can be said is that they left Italy, and that it was a sorry day for Italy when they went.

The fresh vigour which Justinian had breathed into Imperial rule was soon expired. Indeed, barely had the great Emperor died when the Empire again began to crumble, and Italy once more became a happy hunting-ground for barbarian tribes.

In 568 another Teutonic people, the Lombards—the last and least civilised of the German tribes to enter Western Europe—came pouring over the Alps, and within a few years had subdued the greater part of the country. The maritime cities, however, from Ravenna to Ancona—the territory which later became the Papal States—still remained loyal to the Empire; so also did Rome, Venice, and Naples, and the islands of Sicily, Sardinia, and Corsica.

The power of the Lombards, therefore, was broken up and scattered over Italy. In consequence, this people never succeeded in establishing a settled kingdom, but became divided up into a number of local groups, each governed by a "duke" who held his land on a kind of feudal tenure, being bound to support the sovereign with a military levy in time of war.

None the less, they retained their hold on Italy for more than two hundred years. The Italians were too weak to drive them out unaided; and the Eastern Emperors could do nothing to assist, being engaged at this time in a great struggle with the Persians, and a still greater struggle with the Saracens.

Battle of Tours

It would be out of place in this chapter to deal with the rise of the Saracen power. It must suffice, therefore, to say that by the end of the eighth century the disciples of Mahomet, fired with the zeal of their great prophet, who died in 632, had made themselves masters of the most easterly and southern provinces of the Empire, also of a large part of Spain. Moreover, they were only prevented from extending their power into Gaul by the crushing defeat inflicted on them at Tours in 732 by the Frank, Charles Martel.

During these troublous times the Franks made good use of the weakness of their neighbours, and succeeded in establishing themselves indisputably as the most powerful people in western Europe. And by them, as will be shown presently, Italy ultimately was to be delivered from the Lombards.

We have already seen how Clovis (481–511) established a kingdom which stretched from the Pyrenees to the English Channel, and from the Bay of Biscay to and beyond the Rhine. This kingdom did not long remain united. When Clovis died in 511 it was divided among his sons, and became split up into three parts—Eastern Francia, Western Francia, and Burgundy.

BATTLE OF TOURS.
Charles Martel's great victory (A.D. 732) saved Western Europe from the domination of Mahomet's zealous followers, the Saracens.

Now the Franks dwelling along the Rhine were surrounded by other German tribes of kindred race; those dwelling in Gaul, however, had settled as conquerors in the midst of an alien population, and, being in a minority, came gradually to adopt the manners, customs, and language of the people among whom they lived. Thus a very real distinction arose between the people of Western Francia—or Neustria, as it was more commonly called—who had Paris and Soissons as their chief cities, and the people of Eastern Francia—or Austrasia—whose capital was Rheims, and later Metz. And in this distinction, of course, lay the prophecy of future Germany and France.

Clovis was a very great man. His descendants, however, or the Merovingian kings, as they are called, were, almost without exception, creatures beneath contempt, perfidious, cruel, and degenerate. Puppets in crown and robes, they became known as *Les Rois Fainéants;* and of the story of their reigns nothing need be said—it is a dreary chronicle of crimes and savage rivalries.

That the Franks were able to maintain their supremacy in Europe, despite the feebleness of their royal house, was due entirely to the exceptional ability of those on whom the actual work of governing devolved—the mayors of the Palace (Majores Domus). There were three of these Mayors of the Palace—one for Neustria, one for Austrasia, and one for Burgundy, though by the middle of the seventh century all real power had passed into the hands of the Austrasian Mayors of the House of Pepin, who had

From the picture by Professor W. Kaulbach, National Gallery at Rome.

CORONATION OF CHARLEMAGNE AT ROME, A.D. 800.

"To Charles Augustus, crowned of God, the great and peace-giving Emperor, life and victory!" Pope Leo III. advancing to where Charles, wearing the sandals and chlamys of a Roman patrician, kneels in prayer.

established themselves virtually, and later actually, as kings of all the Frankish dominions.

The Carolingians, as this family came to be known, may be compared for personal force and energy to the Norman and Plantagenet kings of England; but as rulers they possessed the unique characteristic that each proved himself a greater man than his predecessor, and that the work of each was the natural and necessary preparation for that of his successor. Charles Martel (714–740), the fourth Mayor of his house, acquired a new dignity for his family by overthrowing the Saracens at the great battle of Tours in 732; and henceforth, although Charles Martel himself personally had leanings towards Teuton paganism, the House of Pepin stood before men as the champion of Christianity.

Papal Prerogatives

Now the Popes had long been looking for someone to whom they could turn to free Italy from the Lombards. The Franks seemed to be naturally suited for the task, and to them the Papacy appealed. Charles Martel turned a deaf ear to the request, for he had an alliance with the Lombards which he valued highly.

Charles's successor, however, Pepin the Short, consented, and on the Pope's behalf saved Rome from a Lombard attack.

Then, according to an early historian, "by the counsel and consent of all the Franks," an embassy was sent to Pope Zacharias to ask his opinion "concerning the kings that were in Francia at that time without kingly power, whether it was well or no. Zacharias shortly replied to Pepin that it was better that he who had the power should be called king rather than he who remained without royal power; and to the end that order might not be disturbed, he bade, by apostolic authority, that Pepin should become king."

Accordingly, in 751 Pepin was proclaimed King of the Franks, and received from the Archbishop of Mainz the novel consecration of anointing.

Many mediæval writers have described the action taken by the Pope in this matter as an assumption of his right to dethrone monarchs and give their crowns to others. This is an unjustifiable over-statement of the facts. Still, it cannot be denied that the Popes acquired a very important addition to their prerogatives by the politic answer given by Zacharias to the question submitted to him by Pepin. It was by his "apostolic authority" that he "bade" Pepin to adopt the title of King; and although at the time nothing of the sort was intended, the manner in which the Pontiff's decision was conveyed and accepted came to be regarded in later ages as an admission on the part of the State of the Church's superiority, and, as such, had far-reaching effects on the liberty and independence of nations.

Pepin died in 768, and in accordance with the Frank rule of inheritance, his dominions were divided between his two sons, Carloman and Charles. Three years later, however, on the death of Carloman, the Frank power was again united under the rule of the other brother, who is known to history as Charlemagne, or Charles the Great.

"The necessary condition of a great ruler in those days was," as Dean Church has written, "that he should be a great warrior." Now Charlemagne, though also a great statesman, was an eminently great soldier. Gradually he brought into subjection all the turbulent barbarian peoples living on the borders and outskirts of his dominions, and finally completed the work began by Pepin, utterly overthrowing the Lombard power in Italy. As a result of this, the Papacy tended more and more to look for support to the Franks, and to attach but little importance to the nominal authority of the Eastern Emperors.

Coronation of Charlemagne

When, therefore, in 797 the Emperor Constantine VI. was blinded and dethroned by his mother, the ex-Empress Irene, who proceeded to reign in her son's stead, Pope Leo III. judged that an excellent opportunity had come for making complete the breach between the Eastern Empire and the Papacy. What right, he asked, had a woman to the throne of Augustus? A woman could not be Cæsar; the time had come for ancient Rome to regain her rights and choose for herself an Emperor.

The Pope offered the title to the King of the Franks, and on Christmas Day, 800, Charlemagne was crowned at St. Peter's, in Rome, by Leo himself as Charles Augustus, Emperor of the Romans. The scene is vividly described in Bryce's "Holy Roman Empire." "Out of the transept a flight of steps led up to the high altar, underneath and just beyond the great arch, the arch of triumph as it was called; behind, in the semicircular apse, sat the clergy, rising tier above tier around its walls; in the midst, high above the rest, and looking down past the altar over the multitude, was placed the Bishop's throne,

itself the curule chair of some forgotten magistrates.

"From that chair the Pope now rose as the reading of the Gospel ended, advanced to where Charles—who had exchanged his simple Frankish dress for the sandals and chlamys of a Roman patrician—knelt in prayer by the high altar; and as, in the sight of all, he placed upon the brow of the barbarian chieftain the diadem of the Cæsars, the church rang to the shout of the multitude, again free, again the lords and centre of the world, 'Carolo Augusto, a Deo coronato, magno et pacifies Imperatori, vita et victoria!'" *

The adoption of the Imperial title by Charlemagne was perhaps the most important occurrence in history since the adoption of Christianity as the religion of the Roman Empire. It was a revival, an adaptation to new conditions of the greatest political institution in the world.

The memory of the Roman Empire had never passed away. What in later ages was called "the fall of the Roman Empire," the deposition of Romulus Augustus in 476, was regarded at the time as the reunion of the Western Empire to the Eastern. Nor was this a mere fiction of the lawyers of Constantinople. It was the living belief of the Roman population of Italy, and probably of the provincials elsewhere, that the rule of the barbaric kings was either an usurpation or legitimised by the grants of such titles as "Consul" or "Patrician."

End of Roman Power

In theory, therefore, the act of 800 was but the reversal of the act of 476—the restoration to Ancient Rome of the dignity which her daughter New Rome had taken from her. Thus the Empire came finally to be divided, and for many generations there continued to be two Emperors, one reigning in the East, the other in the West, yet each claiming to be the true successor of Augustus.

So huge an extent of territory as that over which the first of the Frankish Emperors exercised his sovereign sway could be kept together only by a man of outstanding genius, and on Charlemagne's death in 814 the Empire began immediately to crumble.

He was succeeded by his son Louis the Pious, whom Charlemagne himself saw crowned in 813, thus making the accession secure and indisputable. Louis was a weak but well-meaning man, excessively devoted to the Church. But he was quite unable to maintain order in his dominions. Before he had been long on the throne dissensions broke out on all sides, and he resorted to measures which too clearly bore the stamp of a vacillating mind. He either let things run their course, or he intervened with extreme ferocity. Bernard of Italy, Charlemagne's grandson, he put to death for refusing to acknowledge Lothair, his son, as co-emperor. Further, Louis had no little difficulty in curbing the ambitions of his three sons who, when he died, all flew to arms. An amicable arrangement was eventually made at Verdun in 843 by which Louis' dominions were divided among the brothers.

The youngest Charles was given the western portion; the second son, Louis, the eastern or German portion; whilst Lothair, the eldest, who was designated Emperor, ruled over Italy and a strip of territory—which eventually became Belgium and Lorraine—between the dominions of his brothers.

German Royal Houses

This division marked the real beginning of the nations of modern Europe; and although all the Frankish dominions were nominally united for awhile under the Emperor Charles the Fat (884–887), the land we now call France and the states of Germany became entirely separate entities.

The kingdom of France was really established by Odo, Count of Paris, who was brought into prominence in the early part of the tenth century by the gallant manner in which he defended his city against those same Northmen, or Normans, who, during the following century, conquered England; though the first King of France, officially recognised as such, was Hugh Capet, a grand-nephew of Odo, who was crowned in 987.

At about the same time the head of the ruling Saxon house, Otto the Great, brought the various principalities of Germany under his control, and in 962 united the Roman Empire to his kingdom, being crowned at Rome as Emperor of the Romans by Pope John XII., best known to history as the wickedest of all the Popes.

And from that time forward the Empire was always held by a German king. Whoever was King of Germany was, *ipso facto*, Emperor of the Romans—provided that he went to Rome to be crowned by the Pope. But during the troublous mediæval times many of the kings of Germany failed to do this. Hence the Empire was often without an Emperor.

J. A. B.

* To Charles Augustus, crowned of God, the great and peace-giving Emperor, life and victory.

Continued from page 224.

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CHEMISTRY.—V

Combustion.—In the experiments performed in the last lesson it will have been observed that the containing vessel became hot, or very hot. The question, therefore, arises as to whether a substance evolves more heat when burnt in oxygen than in air.

The answer is in the negative. The amount of heat produced in each case is the same, from the same weight of substance burnt, but in oxygen a far higher temperature is produced, there being no nitrogen present, as in air, to dilute it and take away much of the heat. It should also be noted that the same product is formed whether the combustion takes place in air or in oxygen: in both cases the burning substance unites with the oxygen only.

Combustion therefore consists of an act of chemical combination attended with the production of heat, and usually of light also. There are numerous cases of combustion where no light is visible. The corrosion of various metals, the decay of organic matter, the oxidation of food in the animal body are cases in point; they are commonly spoken of as instances of "slow combustion."

The heat given out by unit weight of a substance is called its *heat of combustion*, and the temperature thereby produced its *temperature of combustion.*

The temperature at which burning begins is called the *ignition temperature*, and this is lower in pure oxygen than in air; it also depends upon the state of division of the material. Thus, finely divided phosphorus catches fire at once on exposure to air, but a stick of phosphorus will only smoulder. Numerous cases are known where certain materials apparently catch fire of their own accord—so-called *spontaneous combustion.*

Serious accidents have arisen from the firing of coal, particularly in ships' bunkers, and still more numerous have been conflagrations caused by the ignition of oily waste, or greasy cotton rags. The self-ignition of coal is due to direct absorption of oxygen from the air. Under ordinary conditions the temperature rises but very little as the exposed surface is small, but where the coal gets broken down by tipping, shunting, etc., its surface is greatly increased, and if this fine material is surrounded by a large amount of unbroken coal, which is a bad conductor of heat, we have all the conditions favourable to spontaneous ignition.

Some oils have the property of slowly absorbing oxygen from the air, and when this takes place rapidly a pronounced increase in temperature results. Hay stacks which have been built before the grass has been thoroughly dried frequently catch fire, the heat in this case being caused by fermentation due to micro-organisms. Practically all cases of spontaneous combustion are due to the slow evolution of heat, which, being confined in non-conducting material, gradually accumulates until the temperature of ignition is reached.

Respiration.—Even the most ignorant of men know that air is essential to breathing, but how many know more than this simple fact?

Experiment XVII.—*To find out if respired air differs from ordinary air.*

Some air from the lungs is collected in a gas-jar over water, in the same way that we collected oxygen. A lighted taper is put into it. The light goes out.

The air we exhale is, therefore, different from the air we inhale.

Breathed air has lost much of its oxygen, which has been taken up by the blood in the lungs, and in its place there is much carbon dioxide and water-vapour formed by the slow combustion of the food in the body. The heat evolved in this act keeps the organism at the temperature necessary for life, 98·4° Fahrenheit, which is some forty to fifty degrees above the temperature of the air.

Our food, therefore, not only helps to build up our tissues, but it provides us with heat. Some foodstuffs have a much greater heat-producing power than others; hence the necessity for, and the increased consumption of, fatty and oily substances in winter. Thus the vital process of men and animals is in the main similar to the chemical process of combustion.

This truth was first clearly recognised by Lavoisier. He pointed out that increased bodily

exercise involves a greater consumption of food if the organism is to remain healthy, and reflected on the injustice of things whereby the poor man who works hardest has to content himself with less food than the rich man, who is too often an idler.

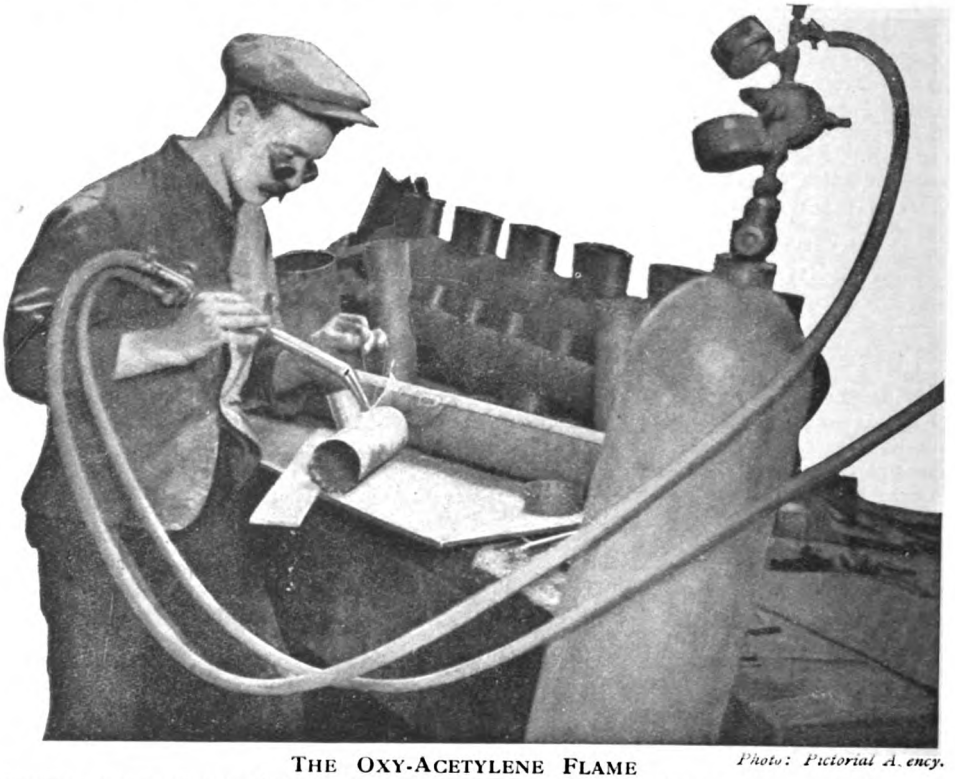
It is not necessary, he said, to be a State official to deserve the gratitude of men and pay tribute to the Fatherland. The scientist in his laboratory can exercise functions just as patriotic; by his work he can lessen the manifold ills and diseases of mankind, he can augment their prosperity and their happiness, and if he could only succeed in lengthening the average human life by a very few years, nay, even only a few days, he could be justly called a benefactor of humanity.

Lavoisier's hope and prediction have been fulfilled. Thanks to exact science the average life of man has been sensibly prolonged in all civilised states. But Lavoisier was before his time. His brilliant work was rewarded by death at the instigation of the Revolutionary Committee in 1794, which declared that "the State has no need of men of science," and so they cut off his head.

Since combustion and respiration both entail the consumption and disappearance of oxygen from the air, the question may well be asked: Why does the oxygen content of the air remain constant? A study of the vital process of plants provides the answer.

The green colouring matter of plants, called chlorophyll, decomposes the carbon dioxide in the air, liberating the oxygen but assimilating the carbon. This action only takes place in sunlight: in the dark, plants, like animals, consume oxygen and give out carbon dioxide. In an aquarium small bubbles of gas can often be observed on the leaves of the plants and weeds immersed in the water. These consist of oxygen, liberated by the chlorophyll from the carbon dioxide dissolved in the water. Even the light from the moon—reflected sunlight—is capable of effecting this decomposition to a slight extent.

Oxygen was discovered by Priestley in 1774 by heating oxide of mercury. It is only within recent times that it has been manufactured and used for medicinal and industrial purposes. It is used in sick-rooms and hospitals for assisting the breathing of patients suffering from weak heart, and it is of the greatest service to aviators when flying at high altitudes. Burnt with hydrogen or coal-gas it is used for making the "limelight" and for melting platinum; more recently the oxy-acetylene flame has been turned to account for welding and



THE OXY-ACETYLENE FLAME *Photo: Pictorial Agency.*

can generate a temperature of 3,600° F. Pieces of iron are touched by the flame of the oxygen-acetylene torch, and are partly melted so that they can be stuck to other pieces of metal with the greatest ease. The oxy-acetylene flame has only been recently turned to account for welding and melting metals. When oxygen can be cheaply produced, its applications will be greatly extended, e.g. in the smelting of ores.

melting metals; when the problem of producing it cheaply has been solved, there is no doubt that its applications will be greatly extended, *e.g.* to the smelting of ores. Oxygen is one of the most wonderful elements in all Nature.

Nitrogen.—In the bell-jar experiment (XI.) oxygen was removed from the air by means of burning phosphorus, leaving the inert gas nitrogen behind. A better and more economical means of isolating this gas is by passing a current of air over heated copper. This metal unites with the atmospheric oxygen to form copper oxide, and the nitrogen passes on and is collected over water. A third method is to suspend a muslin bag filled with iron filings in a large bottle sealed from the air. As already mentioned, on the large scale nitrogen is obtained by liquefying air.

In whatever way it is obtained from the air, it is not pure, as it contains a small proportion of other inert gases always present in the atmosphere. The chief of these is *Argon*, a gas so inactive that it has never been known to unite with anything.

Nitrogen itself is inactive. But although it is a very inert gas it does combine with oxygen and some other substances, hydrogen for example, under certain conditions. It is colourless, tasteless and odourless, a very little lighter than air, and only dissolves in water to a very slight extent. Although this gas is exhaled by men and animals in an unchanged state, it is, nevertheless, a most important constituent of their diet. Man obtains his nitrogen supply from animal flesh, eggs, cheese and to a smaller extent from plant products like peas and beans and nuts. Animals obtain their supply exclusively from plants, which in their turn get it from the soil. The latter replenishes its storehouse by taking nitrogen from decaying animal and vegetable matter, and to some extent from the air. In this way the nitrogen in the world travels through a continuous cycle.

If man had been so constructed that he could assimilate the nitrogen he inhales with every breath, his life-history would have been a profoundly different one.

Nitrogenous Fertilisers.—The fact that man, animals and most plants are only able to assimilate nitrogen in a state of combination is one of fundamental economic importance. It is well known that soils gradually become impoverished and infertile owing to their nutrient constituents—nitrogen, potash and phosphorus—becoming exhausted. Such soils are replenished by the application of animal manures and artificial (chemical) fertilisers. The nitrogenous fertilisers most commonly used are nitrate of soda, which occurs naturally in Chile, and sulphate of ammonia, which is obtained in the distillation of coals and shales. In 1898, Sir William Crookes created a sensation by pointing out that civilisation stood in prospective danger of starvation unless the average yield per acre of wheat could be increased considerably by the application of artificial nitrogenous fertilisers, the supply of naturally-occurring material being limited. The only means of achieving this, he thought, lay in the discovery of some process of "nitrogen fixation," *i.e.* of manufacturing a nitrogenous fertiliser from atmospheric nitrogen as chief raw material. Chemists have already solved this problem, and at the present time very large quantities of sulphate of ammonia, nitrate of lime, and of cynamide ("nitrolim") are being made by processes based upon laboratory experiments.

The explosives industry is also dependent upon "fixed" nitrogen, the essential material, nitric acid, being manufactured from Chilean nitrate. This was a fact of great significance during the late war. If German submarines had succeeded in cutting off our supplies of nitrate from Chile, we should have been forced to sue for peace. As it was, Germany herself was cut off from these supplies, and was forced to develop her home manufacture of synthetic nitrate. This she did in a very successful manner, and now that her nitrogen factories can be turned over to the production of nitrogenous fertilisers, she will probably soon be completely independent of overseas supplies. The United States has also erected large nitrogen works, but Great Britain remains dependent upon Chile.

E. H. T.

HEAT.—IV

18. Absolute Coefficient of Expansion of Liquids.—We have been, in our previous experiments on liquids, dependent upon a knowledge of the expansion of the glass. But the coefficient of expansion of a liquid can be determined directly, and we proceed to describe a simplified form of apparatus, with which this can be done with reasonable accuracy.

A and B (Fig. 26) are glass tubes of about $\frac{3}{8}$-in. bore, and about 30 in. long, bent at right angles at *a* and *b*. The short arms are joined by a stout piece of rubber tubing at *c*, and the line *a b c* is so fixed on a support as to be perfectly horizontal. A is surrounded by a wider glass tube, X, which is to be used as a steam jacket. Pour in the liquid to be examined until it stands at a level of about 25 in. in both A and B.

If A and B are at the same temperature, of course the level will be the same in each; but if A is heated, the liquid in it will expand, and a longer column of it than before will be required to balance the liquid in B. The principle of the method depends on this fact, the lengths being measured when A and B are at known but different temperatures.

The expansion of the glass does not affect the matter, because the height of liquid required to make the balance does not depend on the diameter of the tubes, and would not be altered, if their area was altered. A thermometer should be hung near B, and, steam having been passed through X till the height of the liquid in A is steady, the two heights are measured from the top of the horizontal tube *a c b*.

EXAMPLE.—Length of glycerin in A = 63·7 cm.; temp. = 100°.
Length of glycerin in B = 61·1 cm.; temp. = 12°.

Hence, 61·1 cm., if heated, 100–12° would expand 63·7–61·1 cm.

$$\therefore \text{ coeff. of exp.} = \frac{2{\cdot}6}{61{\cdot}1 \times 88} = 0{\cdot}00048.$$

A number of small errors are inherent in this method, and they can only be avoided by elaborate precautions, involving more complex apparatus; with care in the measurements, however, a reasonably good result can be obtained.

19. Expansion of Water.—We have previously remarked that liquids do not expand regularly through all temperatures; as the temperature rises, and especially as it approaches the boiling-point of the liquid, the rate of expansion increases. Consequently, when we determine the coefficient of expansion of a liquid, we only obtain the *average* coefficient through the range of temperature employed, and this should be specified.

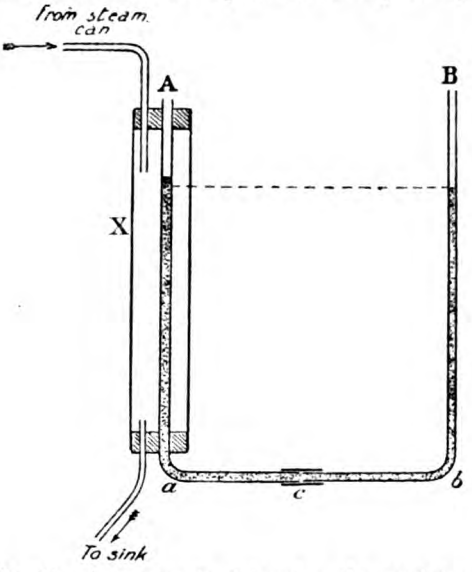


Fig. 26.—Apparatus to determine the coefficient of expansion of a liquid.

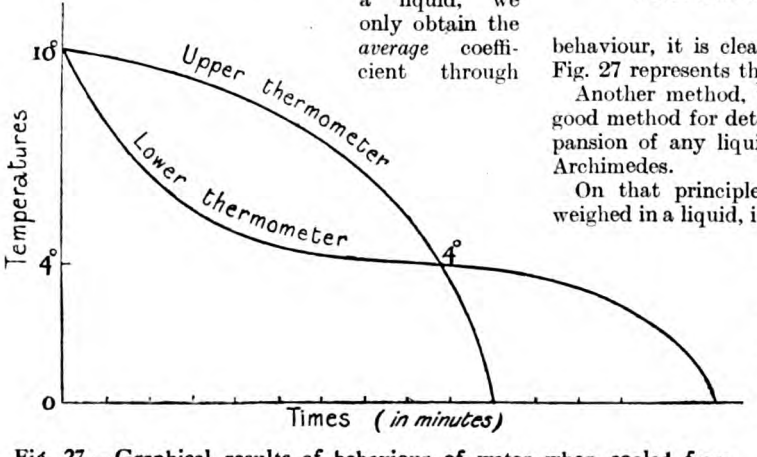


Fig. 27.—Graphical results of behaviour of water when cooled from 10° to 0°.

Water, however, behaves in a particularly irregular fashion. When heated from 0° to 4°, water does not expand at all, but contracts; after 4° it expands, and behaves in general like other liquids. A given quantity of water, therefore, has its smallest bulk at 4°; hence, this temperature is known as the point of *maximum density* of water. The result of this is that the water on the top of a pond is cooled to the freezing-point, while that at the bottom remains at 4°.

This fact can be well illustrated by Hope's apparatus. A cylindrical metal can, C (Fig. 28), has two holes drilled in it at *a* and *b*, in which small accurate thermometers are inserted. Round the middle of C is a second cylinder, D, in which ice can be put. If the two thermometers be then watched, their behaviour will be as follows: That at *a* will show a steady fall of temperature down to 0°; but that at *b* will show a steady fall down to 4° only; at that point its indication will remain at 4°, till *a* has reached 0°, after which it will fall, rather more slowly than *a*, to 0°. From this

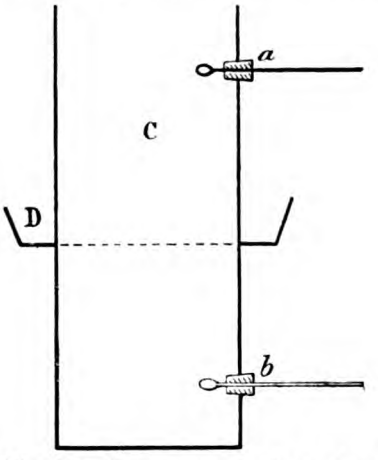


Fig. 28.—Hope's apparatus to determine the coefficient of expansion of water.

behaviour, it is clear that water is densest at 4°. Fig. 27 represents the results graphically.

Another method, which incidentally serves as a good method for determining the coefficient of expansion of any liquid, depends on the principle of Archimedes.

On that principle, we know that, if a solid is weighed in a liquid, it loses weight, in amount equal to the weight of liquid it displaces.

Thus if a solid of volume 20 cc. is weighed in air and then in water at 4°, its loss of weight when hanging in water will be 20 gr., which is the weight of 20 cc. of water at 4°. But if it is weighed in water at 10°, its loss of weight will be less, because the 20 cc. will now be displacing the same volume of water at a smaller density.

By performing this weighing with the solid hanging in water at various temperatures, and making allowance for the expansion of the solid, we find that the loss of weight is greatest when the water

is at 4°, which is therefore the temperature at which the density of the water is greatest.

20. Behaviour of Gases—Influence of Pressure.—In dealing with the expansion of liquids or solids, we are dealing, as we have seen, with very small quantities. The case is quite different when we deal with gases. Moreover, gases yield readily to changes of pressure, as well as to changes of temperature; consequently, the phenomenon of expansion in gases is complicated by the presence of two possible factors as its cause. Liquids and solids contract only very slightly even under very great pressures; but everyone knows how much more air can be forced into a football or bicycle-tyre, for instance, than it normally holds, and that this air readily expands when the restraining pressure is removed. It is an obvious fact of everyday experience also that increase of pressure compresses, or reduces the volume, of a given quantity of air.

Fig. 29.

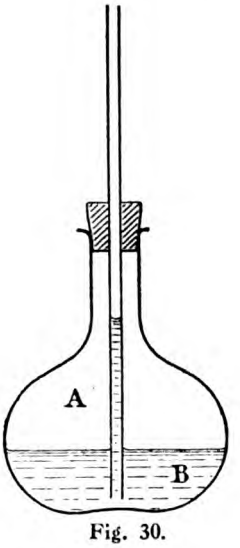


Fig. 30.

Fig. 31.

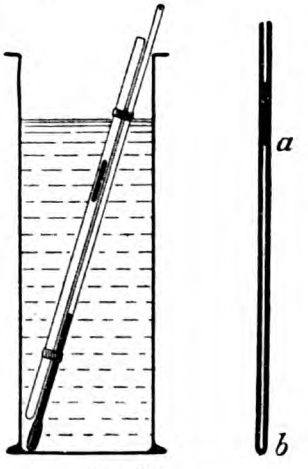


Fig. 32.

Let us first consider the exact relation between the pressure and the volume of a gas like air, the temperature being supposed to remain unchanged. For this purpose we need a siphon tube (Fig. 29), with its short arm closed and its long arm open to the air. Such tubes are to be bought, under the name of "Boyle's tubes," ready for use. Pour some mercury into the open end; with a little adjustment, the amount of air enclosed in *a* may be made such that the level of the mercury is the same in both limbs of the tube. Under these circumstances, the air enclosed in *a* is exerting the same pressure as that of the atmosphere outside. This pressure can, of course, be obtained from the barometer, and it must be carefully recorded. If now we measure the length of the column of air in *a*, we obtain its proportional volume. Some more mercury must next be poured into the open tube, until its height is, say, *h* cm. above the level in the shorter arm. The air in *a* is then clearly supporting the pressure of the atmosphere, and, in addition, that of *h* cm. of mercury. Under this increased pressure its volume is found, by again measuring its length, to be diminished. In order to make this quite definite, we will give a numerical result.

Pressure of atmosphere (read on barometer) = 75 cm. (of mercury).
Increased pressure = 5 cm. (of mercury).
Length of air at 75 cm. pressure = 5·2 cm.
and length of air at 80 cm. pressure = 4·9 cm.

Now $75 \times 5{\cdot}2 = 390$; and $80 \times 4{\cdot}9 = 392$; and these results are so nearly equal that we suspect that, allowing for errors of measurement, they ought to be quite so. We therefore repeat the experiment several times; adding more mercury, and measuring the length of the air at each increase of pressure. The result of these repeated experiments is to confirm us in our suspicion that the pressure, P, multiplied by the volume, V, of this definite quantity of air, is a constant. This result is known in physics as *Boyle's Law*. Put in symbols—PV = constant.

By means of this law, we can easily calculate the effect of pressure on the volume of a gas, and thus allow for it in any experiment.

EXAMPLE.—What is the volume of air at 76 cm. that occupies a volume of 250 cc. at 70·3 cm. pressure?
From Boyle's Law, we have $PV = P'V'$
or $70{\cdot}3 \times 250 = 76 \times V'$
Hence, $V' = \dfrac{70{\cdot}3 \times 250}{76} = 231{\cdot}25$ cc.

21. Effect of Change of Temperature on Gases.—From what has been just said, it is clear that, if we are to study the effect of heat on gases, we must somehow maintain the pressure on the gas at a constant value throughout the experiments.

Notice carefully how this is not achieved in the two experiments we now describe.

1. Take a flask, A (Fig. 30), and fit it up with a cork and tube as in the figure. The long tube through the cork must go right down into the coloured water, B.

Now, if this flask is heated by being plunged into

warm water, the air in it expands; but it can only do this by forcing water up the long tube, as shown. The amount of the water in the tube, however, does not represent the full expansion due to the heat, inasmuch as the air is now under a greater pressure, namely, that of the atmosphere *plus* that due to the water in the tube.

2. Again, take a dry flask, A (Fig. 31), with a cork and tube as before, but with the tube provided with a clip. Heat the flask in boiling water, and while it is hot close the clip. Allow the flask to cool, and then open the clip under a vessel of water. At once a considerable amount of water rushes in, filling something like one-third of the flask.

This, of course, shows that there has been considerable expansion; but it must be again noticed that the air left in the flask is not at the atmospheric pressure under which it was at first; if it were, no water would enter the flask at all. It is at a lower pressure than it was originally, and consequently its volume is a little too great.

22. Coefficient of Expansion of Air at Constant Pressure.—A simple method is to take a piece of straight glass tubing, of rather wide capillary bore, and heat it for some time in the Bunsen flame. This is to dry it completely. Close one end by holding it in the flame, and again pass the whole tube several times through the flame. While it is thus hot, hold the open end in a basin of mercury, until a thread of mercury about ½ in. long is drawn in. Then remove it, and allow to cool.

A column of air is now enclosed, the length of which can be measured at various temperatures. To do this, tie the tube with its closed end downwards to a thermometer, and note the position of the mercury thread when the whole apparatus is placed in water (Fig. 32). We thus obtain the length of *a b* at different temperatures, and the coefficient of expansion can be calculated, allowance being made for experimental error.

EXAMPLE. — Length of air column at $0^\circ = 28$ cm.
" " " " $25^\circ = 30{\cdot}5$ cm.
Hence, 28 cm. expands 2·5 cm. when heated 25°.

$\therefore$ 1 cm. " $\frac{2{\cdot}5}{28 \times 25}$ " " "

$\therefore$ coefficient of expansion $= \frac{2{\cdot}5}{28 \times 25} = 0{\cdot}00357.$

23. Absolute Temperatures and Absolute Zero.—From accurate measurements it has been established that gases have the same value for their coefficient of expansion, viz. 0·00367 or $\frac{1}{273}$. In other words, *all gases expand $\frac{1}{273}$ of their volume at 0°, per degree C. they are heated* (Charles's Law). Hence a given volume of gas will double itself if heated from 0° to 273°. If air is cooled below freezing-point, it loses $\frac{1}{273}$ of its volume per degree; but the process of contraction cannot go on farther than −273°, for at that temperature the air will have contracted $\frac{273}{273}$ of itself, i.e. its volume will have become *nothing*. Hence that temperature will be the *absolute zero* of the thermometer.

The *absolute temperature* will then be that which is measured from this absolute zero as its starting-point. To obtain the absolute temperature, we have simply to add 273 to the ordinary Centigrade temperature. E. W. E.

ZOOLOGY.—V

THE ladder of life lacks many of the rungs by which the animals of to-day have climbed to their kingdom. It is not that there has been a breakdown of material fabric, for life-forms themselves compose the way of ascent. In the family histories of our kings and princes we trace back the line of royal descent for age upon age, but the links with the life in the mud cabin of semi-barbarous days, from which such kings evolved, are snapped, irretrievably lost.

Age-long Struggle for Existence

Still, we know that our kings and princes have to-day their collateral kindred among peasants and paupers; that every king has a slave among his ancestors, every slave a king among his. Imagine a similar process of evolution proceeding in nature, but extending, not over centuries, but over millions of years. Imagine the colossal changes wrought as life, competing with life, has continued and thriven in the types which have slowly acquired new and advantageous characteristics, or have wandered into surroundings more favourable than those from which they emerged. From one group many new forms would gradually arise and diverge, while the ancestral types, having served their purpose, would be gradually exterminated in the passive yet deadly struggle with their better qualified descendants.

It is necessary to have this thought in mind to enable us to understand how it happens that science places the numerous group of animals which we call the insectivora third in the order of mammals, separated only by one great division from that order which contains the apes and man himself.

The Insectivores

At first sight the scheme seems utterly bewildering—a pygmy shrew, just an inch and a half of life adorned with an inch and a half of tail, ranked higher in the plan of creation than the elephant with his big brain, the lion with his giant powers, the dog with his high intelligence and incomparable affection for his human friend. Nevertheless, in tracing relationships the order stated is inevitable.

The myriad living bridges by which progress was made are for ever blotted from the congregation of the living, but the anatomist runs his eye over the skeleton of a hedgehog or a mole, and sees there the

prophecy of bats, carnivora, primates. We cannot say, "Here insectivores end and bats or lemurs begin"; the story is not so simple as that. But we do know from the structure of existing animals, helped by the revelation of allied forms now extinct, that the surviving insectivores descend from the stock which gave to the world the great groups which to-day constitute

Photo: W. S. Berridge, F.Z.S.

THE COMMON SHREW
belongs to an order that ranks higher than that of the elephant.

some of the most important animal groups. The insectivore presents resemblances to the lowest of mammalian types, the egg-laying and pouch-bearing mammals on the one hand, to the bats on the other, and also had affinities with the lemurs.

The name of the order implies that its members are insect-eating mammals. Yet not all insect-eaters are included. The animals whose diet is most exclusively insectivorous—the ant-eaters, do not come within our category; yet an animal which is a herbivore does!

A Diet of Insects

The name suggests that diet is the determining factor, but the reason lies deeper. An insectivore is an animal with certain peculiarities of teeth befitting it specially for a diet of insects, slugs and worms.

The summits of the molar teeth are beset with small conical tubercles suitable for the rapid piercing of this form of diet. There is no grinding surface such as the herbivore requires, no shear- ke action such as distinguishes the work of the carnivore's jaws.

Externally the insectivores much resemble rodents. The shrew answers for the mouse, the jumping shrew for the jerboa, the hedgehog for the porcupine, and so forth. Anatomically, however, there is a wide distinction. No insectivore has the chisel-like incisors of the rodent, nor the tusk-like canine teeth of the carnivores.

In the number, grouping and character of teeth, in the possession of collar-bones uniting the breast-bone with the blade-bones, in the flat-footed walk, the long, slender and mobile snout, and in a general avoidance of competition which daylight and open spaces involve—these are the characteristics which in the main distinguish the group. Some of its representatives, notably the hedgehog, have changed less than the great majority of mammals.

The hedgehog is, as a fact, one of the oldest types of mammal existing. We trace its fossil ancestors back to the very dawn of higher mammalian life, and find it practically unaltered. Like all the members of the order to which it belongs, the hedgehog has the feeblest of brains. In place of brains it has produced prickles, an almost impregnable defence, which, coupled with nocturnal habits, secluded homes and the ability to pass the winter hibernating, has kept this creature alive and flourishing through all the ages of its long unambitious career.

Young hedgehogs have not at first the power to curl up, for the reason that their prickles are soft and "pithy" as the sprout-

Photo: W. S. Berridge, F.Z.S.

LONG-EARED HEDGEHOG
Makes up for in prickles what it lacks in brains.

ing feather of a bird. As the prickles harden, so the power to assume the familiar posture of defence matures, and at the end of a month or six weeks what the prickles lack in rigidity they make up for in sharpness of point. To this fact the oft-punctured hands of the present writer bore witness when he himself brought up a family of five little hedgehogs whose mother had deserted them. She came back to them in the end, and the re-union, in the writer's study, was a sight not to be forgotten.

In intelligence she was wanting, but not in mother-sense or mother-love. With a muddy fore-paw the gleesome, fleasome little matron cuddled one babe beneath her chin ; a second she gently mumbled all over with her mouth, and with low crooning grunts rallied the other three to her furry undersides ; then, content and well pleased, she fed them.

Primarily an insect-eater, the hedgehog enjoys a wide range of diet, frogs—in a big garden where hedgehogs abounded they ate thousands upon thousands, which the writer used yearly to rear—snakes, young birds, eggs, and, of course, slugs and worms.

Photo: W. S. Berridge, F.Z.S.

THE COMMON MOLE,
through its subterranean life, is gradually becoming blind. Sensitiveness of nose is replacing sight.

One adult hedgehog which the writer kept ate for a festival supper forty half-grown slugs, a saucer of roast beef and milk, half a dozen worms, as many cockroaches and two large moths. It is fair to add that the meal was not taken at a gulp ; the living food was eaten at once, but the beef and milk disappeared during the course of the night.

The hedgehog has specialised by converting its hair into a spiky defence. Another famous member of the order, the mole, has specialised by an extraordinary development of the forepaws, which with their four fingers and non-opposable thumb have become one of the most remarkable excavating implements in nature. The elbow is contained within the body, only the wrist and "hand" being free. But this hand is inclined in such a manner that the palm turns outwards and sideways, to furnish the enormous power required in digging the animal's runs and burrows.

The mole practically runs through soft earth when near the surface, but it can tunnel through the stiffest soil, and toss up weights exceeding its own. It has been calculated that were a man to put forth an effort matching that exerted by a mole in the course of a single busy night, he would have to excavate, between sunset and dawn, a tunnel thirty-seven miles long of sufficient dimensions to admit the passage of his body.

The tunnelling of the mole, our finest British engineer, together with the "fortress" that he makes, have been too often described to need repetition here. Of greater interest to us is the fact that this subterranean life of the mole is effecting an evolutionary change before our very eyes.

Blind Moles

The common English mole is not blind, but it is becoming so. The eyes of the mole are gradually losing their function ; it is doubtful if they perceive more than the difference between light and darkness. Extreme sensitiveness of nose, which guides the little animal to his prey, is replacing sight, and though the mole comes out of his run at night it is obvious that his nose rather than his visual organs leads him to the worms with which a damp surface of turf is laced.

In the golden mole the sight seems to have disappeared entirely ; the eyes are useless ; while those of Savi's mole, a South European animal, are not only blind, but are sealed with an opaque membrane. Curiously enough, the star-nosed mole, an American type, with a fleshy sensitive development upon the snout, recalling that of certain of the bats, has not paid in terms of eyesight for the extra gift of tactile equipment.

Moles reach out to many lands, and take many forms. The long-snouted desman is an interesting Russian example, a web-footed miner ; between which and the American star-nosed genus comes the hairy-tailed mole, another American type. But the hedgehogs, too, have foreign kindred. In Burma and the Malay region are the gymnuras, which at first sight suggest rather the large rat than the hedgehog ; for they

are without prickles and possess a naked rat-like tail. But in teeth and anatomical structure they are clearly allied to the spiny ancient of our British woods.

External considerations would suggest that the tenrecs, whose covering is partly hair, partly spines, are the nearest kin to the hedgehog, and a small genus of the group is in fact known as the hedgehog-tenrec; but the great tenrec is an animal measuring sixteen inches in length, is tailless, and, unlike the generality of insectivores, possesses long and sharp canines, which inflict a serious wound. There are also tenrecs with long tails, and there are tenrecs whose habits are aquatic.

Tenrecs of Madagascar

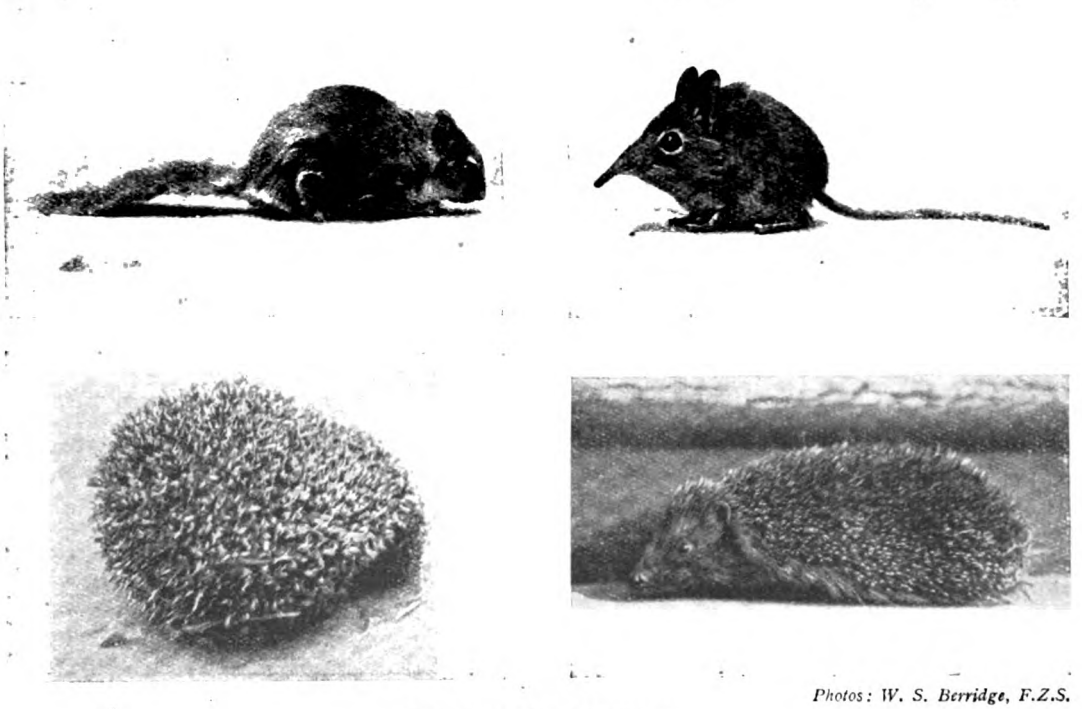
Though the kinship between the tenrecs and the hedgehogs is undeniable, the nearest relative of the former are the solenodons, curious rat-like animals with exceptionally long snouts and feet armed with formidable claws. Tenrecs are of Madagascar and Africa. Solenodons are found only in Haiti and Cuba. There in their twilight life they have sheltered from the dangers which have overcome their kind elsewhere.

They and the tenrecs set out upon evolution's long journey from the point near which hedgehogs started. Great are the differences to-day, yet unmistakable the relationship between them all. They are very ancient, very primitive, dull little brutes, yet precious beyond price as relics of the fauna that once was common in prehistoric Europe.

The Farmer's Best Friend

Not these alone, of course, claim the latter distinction. The shrews, a remarkable group, are of the aristocracy, if antiquity of line be considered. We have in the British Isles the common shrew, the pygmy shrew, and the water-shrew. The almost trunk-like snout should serve to distinguish these animals from mice, but unhappily does not.

One says "unhappily" advisedly, for the shrews are among the best friends of agriculture, destroying enormous numbers of harmful grubs and insects and the young of field-mice. Unlike the moles, they do not burrow, but run among the verdure of field and marsh and the thick shrubberies of the garden.



Photos: W. S. Berridge, F.Z.S.

TYPES OF INSECTIVORES.

Reading from left to right: Top row—The Lesser Flying Squirrel of North America; the Elephant Shrew. Second row—The Hedgehog (curled up for defence); the Hedgehog (ordinary position).

The water-shrew resembles the otter in habit, but its diet is of insects, which it grubs up from beneath stones and gravel in the water.

Superstitious folly invests the shrew with the most malignant qualities. As a matter of fact, however, it is absolutely harmless, and a most valuable ally of the farmer. Shrews, which are the most widespread of the insectivores, have developed a variety of forms and habits. China has shrews which burrow, and shrews which have developed well-webbed feet; whilst Europe, in common with Africa and Asia, regrets the presence of musk-shrews.

Many of the insectivores possess glands from which an offensive fluid is emitted at will, but the musk-shrews leave their scent wherever they go, and in houses render food uneatable and garments unwearable by the malodorous traces left to record their wanderings in the homes of man. The fluid emitted by the skunk, for example, is the animal's only real means of defence. It has a most obnoxious odour, and can be spirted in a fine spray several feet.

Asiatic Tree-Shrews

Far separated from these shrews are the tupais, or tree-shrews, Asiatic types which have developed externally along squirrel-like lines, in outline, fur, tail and dwelling. But the long muzzle, the rounded ears, and the teeth all proclaim the insectivore, though it should be added that these animals add fruit to their mainly insectivorous diet. Most of the insectivores have found refuge underground or in the tiny dim aisles of shaded swamps, meadows and woodland, but the tupais, having taken to the trees, are enabled to enjoy the light of day amid their leafy retreats. One Malayan species, indeed, when the flooded days of the rainy season arrive, emboldened by the glimpses of the sun and the sight of man, actually ventures into human habitations, to crave the loan of a spider or cockroach.

One of these tree-shrews has specially to be noted—the pen-tailed tupai, which possesses the most remarkable of plumed appendages. What purpose the development can serve is not obvious, but the bare upper part, and the plumed lower portion, with hairs arranged after the fashion of the vane of a feather, is one of the most striking features of this curious group of animals.

There remain the jumping shrews, which have the hind legs so fashioned that they move by leaps and bounds, like jerboas, or the tiniest of tiny kangaroos. These shrews have from forty to forty-two teeth, but, in the same continent with themselves—Africa—there is a localised genus, the long-nosed jumping shrew, which has a snout so long and slender as to suggest the way towards the trunk of the elephant.

All the shrews employ their elongated muzzles for grubbing in soft, damp soil and vegetation in quest of insects, but the excessive flexibility of the proboscis of the shrews last mentioned would seem hindrance rather than aid.

Finally there is the otter-shrew, which is placed in a distinct family by itself, the Potamogalidæ. This is a relatively large animal, measuring some twenty-two inches from snout to tip of tail, and except for ineffaceable internal evidences would readily pass for a small specialised otter. If we may not look a gift horse in the mouth, it is imperative that we seek the story of his origin in the mouth of an otter-shrew, for, though the long muzzle is there, it is so broadened and flattened as to suggest the animal in whose likeness it seems to be made.

The otter-shrew is the most aquatic of all the insectivores, for though the toes are not webbed, the nostrils, when the animal is under water, are automatically closed by valves.

Flying Lemur

There is perhaps no stranger example of mimicry among mammals than this resemblance of a shrew to an otter.

The most interesting of all the insectivores is reserved to the last, though in point of scientific classification it should come at the head of the table. This is the cobego or flying lemur.

Here is a very ancient mammal which at some time in its past history progressed far towards development into a species of bat, but, having webbed its fingers and toes, and grown a parachute-like extension of the skin extending between the neck and the fore-limbs, the fore-limbs and the hind-limbs, the hind-limbs and the tail, stopped short of true flight, and remained a gliding, tree-dwelling animal. Some naturalists claim it for the bat kingdom; others would have it with the marsupials, but the character of its brain and the nature of its teeth have at last decided the question. It is referred to a special family of the insectivores.

Among its teeth are types unlike those of any other living animal. The lower incisors are fashioned with comb-like crowns, a very archaic type of tooth, telling a tale of a pattern inherited from the earliest mammalian life. These remain, with a brain as primitive; yet the specialised web-invested tail is as good a grasping organ as that of an American monkey.

A host of nature's experiments are represented in the structure of the cobego, which, fashioned like an insectivore, is exclusively vegetarian in diet. Sluggish as a climber, it parachutes from the summit of one tree to the root or trunk of another. Russell Wallace saw one "fly" seventy yards, with a descent of less than forty feet in height, proving control of flight in mid-air.

A deeply interesting study is the cobego, one of the strangest products of the silent byways of island existence, where insulation saves ancient life forms from the stress of competition with higher and more powerful animals. But it can be said of all the insectivores that they have to a certain extent insulated themselves. They have gone underground, or taken to the trees, or to the water and its stilly margins, or hidden in the deep recesses of undergrowth. They live as stewards who have hidden their talents in the earth.

In ancient days their kin came into the hurly-burly of life's central conflicts. These lingered secretly in the primrose paths of dalliance, and remained as they began, merely insectivora. E. A. B.

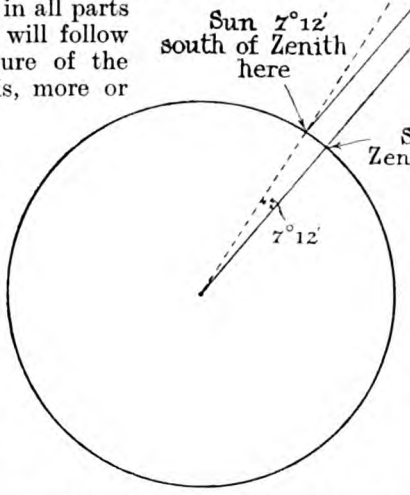
The Skunk, like many insectivores, protects itself by emitting an offensive fluid secreted by a pair of special glands, which supply its only real means of defence.

ASTRONOMY.—V

THE determination of the shape and size of the earth is essentially an astronomical problem. It is true that one of the obvious proofs of the earth's rotundity is the disappearance of a ship at sea, not by gradually fading away in the distance, but by the very quick disappearance of the hull below the apparent surface of the sea, while the masts and spars remain perfectly clear and distinct.

Size and Shape of the Earth

This is in itself a plain indication that the surface of the sea is curved; and since the effect is, so far as one can see, of about the same magnitude in all parts of the world, it will follow that the curvature of the earth's surface is, more or less, the same everywhere, and that the shape of the earth cannot be far from spherical. And one might go farther and get a rough determination of the size of the earth by such terrestrial means as measuring the dip of the horizon from a high point of view, as from the peak of Teneriffe. But these are rough and crude methods, and for any precise knowledge of the size and shape of the earth we must go to the stars.



Geometrical diagram of Eratosthenes' experiment (250 B.C.) by which the measurement of the earth's circumference was approximately determined

The method used to-day is that which was first used, so far as we know, by the astronomer Eratosthenes, librarian of the Alexandrian Library, who about 250 B.C. was able to make a measurement of the diameter of the earth, which came out, partly by good fortune, considerably near the truth.

The method depends upon the fact, which any observer and traveller must notice, that as one goes south the sun at noon on a given day of the year is higher. It was a piece of common knowledge that at Syene, on the River Nile, in the neighbourhood of the first cataract, the sun at noon on midsummer day casts no shadow, being precisely overhead. Eratosthenes measured the elevation of the sun on the same day at Alexandria, and found that the sun was 7° 12′ from the zenith at its highest. He knew, also, or perhaps he measured, the distance from Alexandria south to Syene; it was 5,000 stadia, whence he concluded that the circumference of the earth must be 250,000 stadia.

A glance at the figure will show that this is a very simple application of that science of Geometry, whose name means the "measurement of the earth." If on a given date the sun is 7° 12′ higher at one place than at another, it means that the difference of latitude of those two places expressed in degrees is denoted by 7° 12′, which is a fiftieth of the circumference of the whole circle. Equally then, if the distance measured along the ground is 5,000 stadia, the circumference of the whole earth must be fifty times that, or 250,000 stadia.

Eratosthenes' Experiment

It used to be said that as we did not know the length of the stadium, it was impossible to tell how near this measure of Eratosthenes was to the truth. It is, however, confidently asserted nowadays that, on the authority of Pliny, 40 stadia = 1 schoinos = 1,200 royal cubits, each = 0·525 metres, whence it would follow that a stadium equals 15·75 metres, and the whole circumference of the earth 39,400 km., which is sufficiently near the truth to be very creditable to Eratosthenes. The success of his calculation, however, was partly due to good luck.

Like most of the other problems of the time, it remained very much in the same condition for many hundreds of years. Certain attempts had been made in England to measure the length of a degree, by Gilbert Norwood about 1570, and by Halley at the instigation of the Royal Society a hundred years later. These attempts do not add very much to the history of the subject. The problem became acute when Newton showed that since the earth was rotating on its axis, and presumably had always been rotating, it could not be a true sphere, but must be

bulged at the equator by what is ordinarily called centrifugal force.

The French astronomer Cassini, on the other hand, maintained that, so far as measurement went, it was the polar axis of the earth and not the equatorial that was the longer. Such a question could not be left in dispute. It was essential for the credit of science that it should be settled in the only way possible, by measurement at various points of the earth's surface. If we look at the figure we shall see that if the earth really bulges at the Equator there must be a difference in the curvature of the meridian as one goes north, and that measurements made on the principle of Eratosthenes will give a smaller result for the value of 1° of latitude on the equator than they will at the pole.

For the purposes of measurement the poles were inaccessible then, as they are now; but it was not necessary to go right to the poles to establish the principle. In the middle of the eighteenth century the Paris Academy of Sciences fitted out two expeditions, the one to Tornea, Lapland, at the head of the Gulf of Bothnia; the other to the high plateau of the Andes, on the equator in Peru.

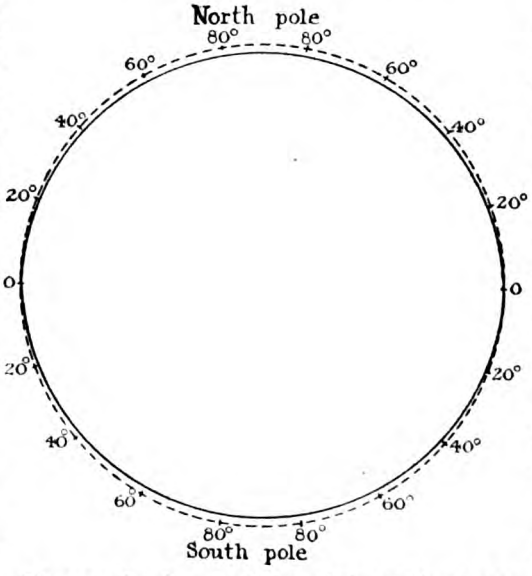


Diagram showing the bulge of the earth at the equator.

These measures were conclusive in showing that Newton was right, and that the earth protruded at the equator, as the theory of gravitation demanded. And in the words of Voltaire, "the Academicians flattened both the poles and Cassini."

But about the same time the Abbé de la Caille was measuring an arc of meridian at the Cape of Good Hope, which gave the curious result that, whatever might be the case in the northern hemisphere, in the southern the curvature got greater as one went south. It was then for a time contended that the earth was egg-shaped, flatter at one end and more pointed at the other, and it took long to clear up this very anomalous result. Its explanation will lead us deeper than for the moment we desire to go.

The next point of interest in the theory of the figure of the earth relates to the establishment of the metric system of weights and measures. Throughout mediæval Europe there was an immense confusion in the units of lengths. Our own unit, the yard, is by tradition derived from the length of the arm of King Henry the First. In practice, it was the length of a bar of iron dating from the time of Elizabeth, which served as a standard until it was destroyed in the fire which consumed the Houses of Parliament in 1834.

In the States of Central Europe there were as many different feet as there were States. In France the unit of length, the toise, had no definite relation to other European measures, and the various standards differed among themselves. It seemed to the precise French scientific mind that the proper unit to take was one depending in some simple way upon the dimensions of the earth, wherefore it was resolved to adopt as the unit the ten-millionth part of the distance from the equator to the pole along the meridian of Paris.

At the time of the French Revolution operations were in full swing for making a new determination of the length of this quadrant, using the flattening of the earth as determined by the Academicians, combined with a new determination of the length of the meridian in France from Dunkirk to Barcelona. These measurements resulted in the establishment of the unit of length, the metre, which is the basis of the metric system of weights and measures adopted by so large a part of the world to-day.

The principle on which the system is based is in reality unsound, since it is not possible to arrive at any finality in such a determination as the length of the quadrant of the earth. However well it may be done at any one time, the continual improvement in instrumental methods, and the continual discovery of new sources of error to be guarded against, makes it inevitable that

every new careful determination shall be better than the last, and that the older can only by chance agree with the newer.

And to-day, in the light of our present knowledge we can say with certainty that the metre, as determined a hundred years ago, differs by about one part in five thousand from what it was intended to be—the ten-millionth of the quadrant of the earth.

But it is impossible to be continually altering the standard of length, each time a more precise determination is made of the size of the earth. We therefore come back in practice to taking as our standard the length of a certain bar of metal. It is rather more scientific to have that bar an attempt at a natural quantity, rather than the supposed length of a monarch's arm. But for practical purposes one is as good as the other, except that it is perhaps easier to persuade the world at large to adopt the so-called natural unit.

Metric System

The real merit of the metric system lies not in its unit of length, but in the fact that all the other units, of area, and of mass, and of capacity, have a simple decimal relation to the unit of length. In scientific work that is a very real advantage. But is it in common life ? There is a continual agitation to supersede the British system of weights and measures by the metric system, and there is, naturally, very much to be said both for and against the proposed change. The complication of the British system is notorious and indefensible ; yet it does not necessarily follow that the best reform would be to sweep it away altogether, and to involve every trade and industry in the confusion that would necessarily result from such a change.

Undoubtedly the best solution would be to make greater use of the real merit of the metric system, its decimal basis, and to work in decimals of whatever existing unit proved to be the most convenient.

For example, if railway rates were calculated in tons and decimals of tons, instead of tons, hundredweights, quarters, and pounds, there would be a great saving of arithmetic.

We turn now to some remarkable results of recent work on the figure of the earth. About the middle of last century it became a serious question in the survey of India, what was the effect upon the plumb line of the attraction of the immense mass of the Himalaya Mountains and the plateau of Tibet, which lie in the north of India. The measurement of a meridian arc depends, as we have seen, upon the measurement of latitude at two ends of the arc, and of the length in yards, or feet, or metres, or whatever may be the unit adopted, along the surface of the earth from one end to the other.

The astronomical observations of latitude consist, in principle, of the determination of the height of the pole above the horizon, the horizon being determined by some such instrumental means as a very finely made spirit-level, or the supposed horizontal surface of a dish of mercury.

Both the bubble and the surface of mercury are controlled by the direction of gravity, so that if there is anything, such as a great mountain mass, to make the direction of gravity abnormal, the latitude will be abnormal by the same amount. Any such deviation of the vertical out of the perpendicular to the supposed regular figure of the earth is called local attraction ; and the study of local attraction has given us some quite new ideas about the constitution of the earth's crust.

Without going into the complicated details of about forty years' work in India, we may say that the general result is this : The mass of the Himalayas does not exert upon the plumb line that influence which might be expected ; nor does the deficiency of density in the deep ocean to the south of India produce, as might be expected, an effect of the opposite kind. It is clearly proved that both the excess of matter to the north and the deficiency to the south have only a comparatively small part of the effect that they would have if they were not compensated in some way or other. And the question is : How is this compensation effected ?

The Attraction of Mountains

The problem was raised first in India ; but it has, of course, been taken up in other parts of the world. With great variation in detail the general result is everywhere the same, that the direction of the pendulum of the plumb line and the actual force of gravitation are, to a great extent, independent of the visible inequalities in the distribution of mass. Great mountain ranges produce but little of the effect which one could expect them to have ; and the great oceans behave as if they were made of rock instead of water.

The only possible conclusion is, that below mountain masses there is a deficiency of density which about balances them ; while the crust below the floor of the great oceans must be of density greater than the normal, to make up for the relative lightness of the water above.

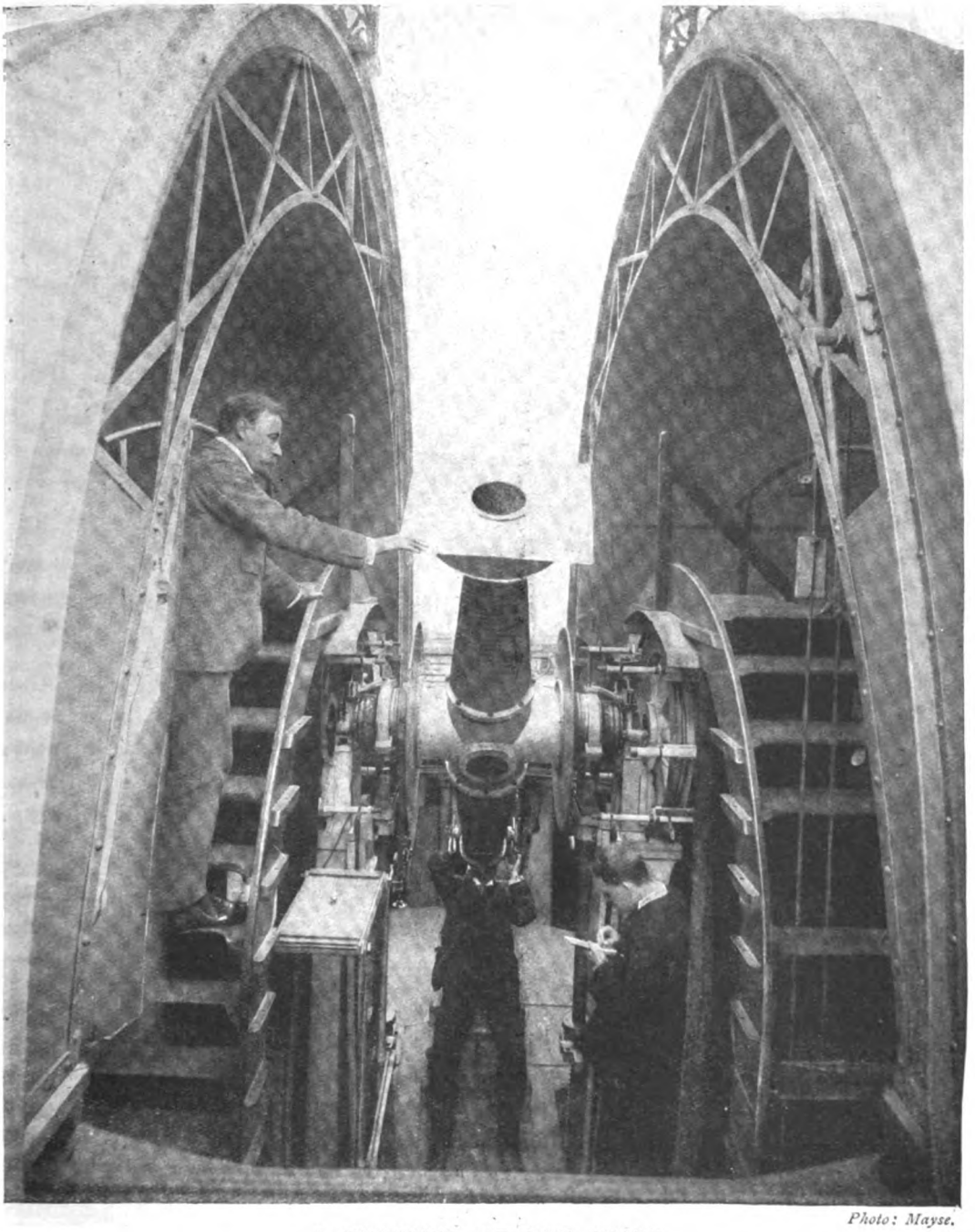


Photo: Mayse.

A WATCHER OF THE STARS.

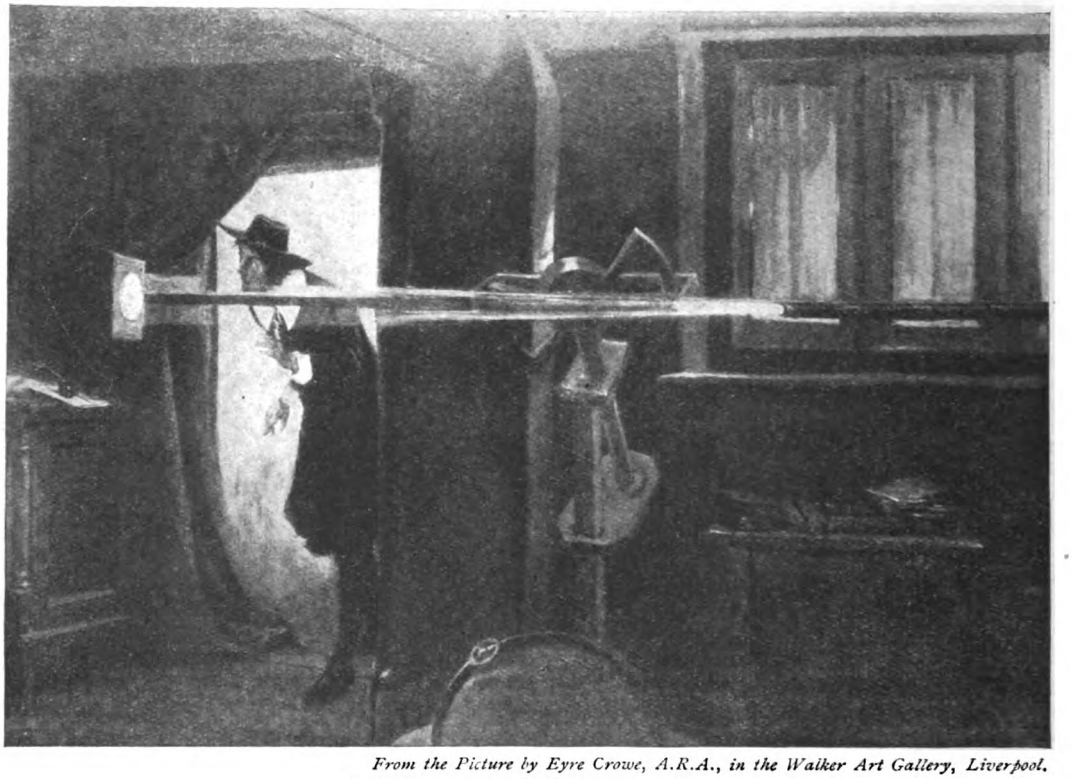
Mr. Frank W. Dyson, the Astronomer Royal, taking a reading with an altazimuth. This instrument is used to determine the altitudes and azimuths of celestial objects, azimuth being the angular distance of the heavenly body from the north or south point of the horizon.

This idea of a balance in the crust of the earth destroys the old idea, which so often appears in the books, that the attraction of a great mountain mass like the Himalayas or the Andes must heap up the water of the ocean round about. It has often been said that the surface of the ocean at the mouth of the Hooghli must be three or four hundred feet farther from the centre of the earth than the surface at Cape Comorin in the south of India; while a greater estimate has been formed of the effect of the attraction of the Andes in heaping up the waters of the Pacific.

It is practically impossible to prove the existence of such an effect by ordinary operations of survey, because the same cause which would heap up the water would deflect the spirit levels of the surveyors' instruments. And even if there were such a raising of the waters of the Pacific, it is, of course, absurd to suppose that there would be any inconvenience caused in the Panama Canal, for example. If it were natural for the Pacific to stand high, it would be natural for the water to run uphill, so to speak, in the Canal, and no one would be a penny the worse or a penny the wiser. There are, however, as we have seen, the best reasons for supposing that no such great anomalies exist in the distance from the centre of the earth to different parts of the ocean's surface.

An allied effect of the figure of the earth on the force of gravity makes itself evident in the rate of a clock. So long ago as the seventeenth century it was observed by Richer that a clock which kept accurate time in Paris lost two minutes a day when taken to the equator. This was evidently due to the fact that the equator is farther away than Paris from the centre of the earth owing to the equatorial bulge, so that the force of gravity of the earth is diminished.

Since that first experiment a very great deal of knowledge has been accumulated from experiments with very carefully designed pendulums, which are made so that they are invariable in size and in mass, and are suspended in such a way that their time of oscillation can be determined with extreme accuracy. A. R. H.



From the Picture by Eyre Crowe, A.R.A., in the Walker Art Gallery, Liverpool.

THE FIRST ENGLISH ASTRONOMER.

Jeremiah Horrocks (1619–1642) observing the shadow cast by Venus as it crosses a point between the sun and the earth at almost the moment his calculations had led him to predict. His apparatus consisted of a dark room with a single opening for the sun's disc.

Continued from page 232.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—V

We come now to a number of adjectives which form their comparative and superlative irregularly.

(1) In the following the comparative and superlative are not formed from the positive :

Positive.	*Comparative.*	*Superlative.*
bŏnŭs, *good*	mĕlĭŏr	optĭmŭs.
mălŭs, *bad*	pējŏr	pessimŭs.
parvŭs, *small*	mĭnŏr	mīnĭmŭs.
multŭs, *much*	plus (n.)	plūrĭmŭs.
magnŭs, *great*	mājŏr	maxĭmŭs.
nēquam, *wicked*	nēquĭŏr	nēquissĭmŭs.

Corresponding to the noun **jŭvĕnĭs**, *young man*, there is a comparative adjective **jūnĭŏr**, *younger*, and to the noun **sĕnex**, *old man*, a comparative **sĕnĭŏr**, *older*. Neither of these comparative adjectives has a positive or a superlative, for the latter degree the phrases **nātū mĭnĭmŭs**, *least by birth* or *youngest*, and **nātu maxĭmŭs**, *greatest by birth* or *oldest*, being substituted. **Ocĭŏr**, *swifter*, has a superlative, **ōcissĭmŭs**, but no positive. **Sātĭs**, *enough*, has the neuter comparative **satĭŭs**, but no superlative. **Dīvĕs**, *rich*, usually has the comparative and superlative in a contracted form **dītĭŏr** and **dītissĭmŭs** (or **dīvĭtĭŏr** and **dīvĭtissĭmŭs**. **Plūs**, the comparative of **multus**, *much*, is a neuter noun (gen. **plūrĭs**) without a masculine or feminine. In the plural it is declined as follows :—

	Masc. and Fem.	*Neut.*
N.V. Acc.	plūrēs	plūră
Gen.	plūrĭum	
Dat. Abl.	plūrĭbŭs	

(2) Some adjectives, derived from prepositions or adverbs, are irregularly compared, as follows :—

Preposition or Adverb.	*Positive.*	*Comparative.*	*Superlative.*
citrā, *on this side*		cĭtĕrĭŏr	cĭtĭmŭs.
dē, *down from*		dētĕrĭŏr, *worse*	dēterrĭmŭs, *worst.*
extra, *outside*	exterŭs (*a*),	extĕrĭor	extĭmus or extrēmus.
infra, *below*	infĕrŭs	infĕrior	infĭmus or ĭmus.
intrā, *within*		intĕrĭŏr	intĭmŭs.
post, *behind*	postĕrŭs	postĕrĭŏr	postrēmŭs or postŭmus.
prae, *before*		prĭŏr	prīmŭs.
prŏpĕ, *near*		prŏprĭŏr	proxĭmŭs.
sŭpĕr, *above*	sŭpĕrŭs	sŭpĕrĭŏr	sŭprēmŭs or summŭs.
ultrā, *beyond*		ultĕrĭŏr	ultĭmŭs.

(3) With some few exceptions, adjectives ending in **-us** after a vowel (other than **u** in the combination **gu-** or **qu-**) do not form the comparative and superlative by means of inflexion, but use **măgĭs** for the comparative and **maxĭmē** for the superlative, as follows :—

Positive.	*Comparative.*	*Superlative.*
conscĭŭs, *aware*	măgĭs conscĭŭs	maxĭmē conscĭŭs
nescĭŭs, *unaware*	măgĭs nescĭŭs	maxĭmē nescĭŭs
vărĭŭs, *diverse*	măgĭs vărĭŭs	maxĭmē vărĭŭs

But —

longinqŭŭs, *extensive*	longinquĭŏr	longinquissĭmŭs
pinguĭs, *fat*	pinguĭŏr	pinguissĭmŭs

Some words, like **bellŭs**, *handsome*, **falsŭs**, *false*, **invītŭs**, *unwilling*, **săcĕr**, *sacred*, etc., take the superlative inflexion but not the comparative. This is a result of usage such as often occurs in any language.

Comparison of Adverbs

Before proceeding to the numerals it will be helpful at this point to deal with the comparison of adverbs, although for the present only a few adverbs need be learnt for application in the exercises.

A comparative adverb is simply the neuter nominative singular of the corresponding comparative adjective.

The superlative is formed by changing the final syllable of the corresponding superlative adjective to **-ē**, as follows :—

	Positive.	*Comparative.*	*Superlative.*
Adj.	ācĕr, *sharp*	ācr-**ĭŏr**	ācer-**rĭmŭs.**
Adv.	ācrĭtĕr, *sharply*	ācr-**ĭŭs**	ācer-**rĭmē.**
Adj.	doctŭs, *learned*	doct-**ĭŏr**	doct-**issĭmŭs.**
Adv.	doctē, *learnedly*	doct-**ĭŭs**	doct-**issĭmē.**
Adj.	făcĭlĭs, *easy*	făcĭl-**ĭŏr**	făcil-**lĭmŭs.**
Adv.	făcĭlē, *easily*	făcĭl-**ĭŭs**	făcil-**lĭmē.**
Adj.	bŏnŭs, *good*	mĕl-**ĭŏr**	opt-**ĭmŭs.**
Adv.	bĕnĕ, *well*	mĕl-**ĭŭs**	opt-**imē.**
Adj.	mălŭs, *bad*	pē-**ĭŏr**	pe-**ssĭmŭs.**
Adv.	mălĕ, *ill*	pē-**ĭŭs**	pe-**ssĭmē.**

Adverbs not formed from adjectives have similar forms in the comparative and superlative, thus :—

Positive.	*Comparative.*	*Superlative.*
dĭū, *for a long time*	dĭū-**tĭŭs**	dĭū-**tissĭmē.**
nūpĕr, *lately*		nūper-**rĭmē.**
saepĕ, *often*	saep-**ĭŭs**	saep-**issĭmē.**
sĕcŭs, *otherwise*	sēc-**ĭŭs** (sētĭŭs)	
tempŏrī (tempĕrī), *timely*	tempĕr-**ĭŭs**	

But—

magnŏpĕrĕ, *greatly* măgĭs, *more* maxĭmē, *most.*
multum, *much* plūs, *more* plūrĭmum, *most.*

After **măgĭs**, **plūs**, or other comparative adjectives or adverbs, **quam** is used, as will be more fully explained when we come to syntax, very much as *than* is used in English. Thus—

plus argenti quam, *more* (of) *money than.*
clarior quam, *more brilliant than.*

But often **quam** is omitted, and after the comparative the ablative is used instead as in **quid est mollius unda** ? *What is softer than water ?* instead of **quid est mollius quam unda ?**

The Numerals

Apart from one numeral that is a noun, **mīlĭă** (n.) *thousands*, the numerals in Latin may be divided into four classes, of which the first three are adjectives and the fourth adverbs :—

(1) Cardinal Numerals, corresponding to the English *one*, *two*, *three*, etc.

(2) Ordinals, corresponding to *first*, *second*, *third*, etc.

(3) Distributive Numerals, meaning *one each*, *two each* (or *two together*, *two by two*, etc.), *three each*, etc.

(4) Numeral Adverbs, signifying *once*, *twice*, *thrice*, etc.

In the table on p. 291 the declinable portion of each numeral is printed in heavy type. There is no need for the student to learn at once by heart more than the first column and the lower numerals in the other columns. But since the compound numerals are formed in accordance with invariable rules, no great difficulty will be found in recognising and learning them.

It will be noticed that of the four classes of numerals only the second and third are regularly declined. Of the cardinal numerals only the following are declined : **ūnŭs**, *one*, **dŭŏ**, *two*, **trēs**, *three*, **mīlĭă**, *thousands*, when it is a plural substantive, and the numerals **dŭcentī**, **trĕcentī**, etc., up to **nongentī**. The inflected cardinal numerals are thus declined :—

Ūnŭs, -ă, -um, *one*

Singular.

	Masc.	*Fem.*	*Neut.*
Nom.	ūn-**ŭs**	ūn-**ă**	ūn-**um.**
Voc.	ūn-**ĕ**	ūn-**ă**	ūn-**um.**
Acc.	ūn-**um**	ūn-**am**	ūn-**um.**
Gen.	ūn-**ĭŭs**	ūn-**ĭŭs**	ūn-**ĭŭs.**
Dat.	ūn-**ī**	ūn-**ī**	ūn-**ī.**
Abl.	ūn-**ō**	ūn-**ā**	ūn-**ō.**

Plural (rarely used) *

Nom.	ūnī	ūnae	ūnă.
Voc.	ūnī	ūnae	ūnă.
Acc.	ūnōs	ūnās	ūnarum.
Gen.	ūnōrum	ūnārum	ūnorum.
Dat.	ūnis	ūnīs	ūnīs.
Abl.	ūnīs	ūnīs	ūnīs.

Dŭŏ, -ae, -ŏ, *two*

	Masc.	*Fem.*	*Neut.*
N.V.	dŭ-**ŏ**	dŭ-**ae**	dŭ-**ŏ.**
Acc.	dŭŏ- (*or* dŭ-**ōs**)	dŭ-**ās**	dŭ-**ŏ.**
Gen.	dŭ-**ōrum** (*or* dŭ-**um**)	dŭ-**ārum**	dŭ-**ōrum.**
Dat.	dŭ-**ōbŭs**	dŭ-**ābŭs**	dŭ-**ōbŭs.**
Abl.	dŭ-**ōbŭs**	dŭ-**ābŭs**	dŭ-**ōbŭs.**

Trēs, trĭă, *three*

	Masc. and Fem.	*Neut.*
N.V.	tr-**ēs**	tr-**ĭă.**
Acc.	tr-**ēs** (*or* tr-**īs**)	tr-**ĭă.**
Gen.	tr-**ĭum**	tr-**ĭum.**
Dat.	tr-**ĭbŭs**	tr-**ĭbŭs.**
Abl.	tr-**ĭbŭs**	tr-**ĭbŭs.**

Decline **ambŏ**, *both*, *the two*, like **dŭŏ**. The cardinal numerals **dŭcentī** to **nongentī** are declined like the plural of **bŏnŭs**, usually, however, having the genitive plural in **-um**, not **-orum** or **-arum**, as in **dŭcentum**. **Mille** is declined only in the plural, when it is used as a substantive, and declined thus :—

N.V.A.	mīl-**ĭă**
Gen.	mīl-**ĭum**
Dat. Abl.	mīl-**ĭbŭs**

* **Ūnus** is used in the plural when it agrees with a plural substantive having a singular meaning, as **ūnae lĭtĕrae**, *one letter.*

A declinable numeral qualifying **mīlĭă** agrees with it, the substantive dependent on **mīlĭă** being in the genitive, as **trĭă mīlĭă passuum**, *three thousand paces*.

Uses of the Numerals

The cardinal and ordinal numerals are used very much in the same way as in English. In dates, however, the ordinal is used and not the cardinal; thus, **anno ante Christum centesimo**, *in the year* 100 B.C.

The distributives are used:—

(1) To express the number of things belonging to each of several persons, as **Germani singulis uxoribus contenti sunt**, *the Germans are content with one wife each*.

Table of Numerals

Cardinal.	*Ordinal.*	*Distributive.*	*Adverbial.*	*Roman Symbol.*
1. **ūnŭs.**	prīmŭs.	singŭlī.	sĕmĕl.	I.
2. dŭŏ.	sĕcundŭs (or altĕr)*.	bīnī.	bĭs.	II.
3. trēs.	tertĭŭs.	ternī (or trīnī).	tĕr.	III.
4. quattŭŏr.	quartŭs.	quăternī.	quătĕr.	IV.
5. quinquĕ.	quintŭs.	quīnī	quinquĭēs.	V.
6. sex.	sextŭs.	sēnī.	sexĭēs.	VI.
7. septem.	septĭmus.	septēnī.	septĭēs.	VII.
8. octŏ.	octāvŭs.	octŏnī.	octĭēs.	VIII.
9. nŏvem.	nōnŭs.	novēnī.	nŏvĭēs.	IX.
10. dĕcem.	dĕcĭmŭs.	dēnī.	dĕcĭēs.	X
11. undĕcim.	undĕcĭmŭs.	undēnī	undĕcĭēs.	XI.
12 dŭŏdĕcim.	dŭŏdĕcĭmus.	dŭŏdēnī.	dŭŏdĕcĭēs.	XII.
13. trĕdĕcim.	tertĭŭs dĕcĭmŭs.	ternī dēnī.	terdĕcĭēs.	XIII.
14. quattŭŏrdĕcim.	quartŭs dĕcĭmŭs.	quăternī dēnī.	quătŭŏrdĕcĭēs.	XIV.
15. quindĕcim.	quintŭs dĕcĭmŭs.	quīnī dēnī.	quindĕcĭēs.	XV.
16. sēdĕcim.	sextŭs dĕcĭmŭs.	sēnī dēnī.	sēdĕcĭēs.	XVI.
17. septemdĕcim.	septĭmŭs dĕcĭmŭs.	septēnī dēnī.	septĭēs dĕcĭēs.	XVII
18. dŭŏdēvīgintī.	dŭŏdēvīcēsĭmŭs.	dŭŏdēvīcēnī.	dŭŏdēvīcĭēs.	XVIII.
19. undēvīgintī.	undēvīcēsĭmŭs.	undēvīcēnī.	undēvīcĭēs.	XIX.
20. vīgintī.	vīcēsĭmŭs.	vīcēnī.	vīcĭēs.	XX.
21. **ūnus** et vīgintī (or vīgintī **ūnŭs**).	prīmŭs et vīcēsĭmus (*or* **vīcēsimŭs prīmŭs**).	vīcēnī singŭlī.	sĕmĕl et vīcĭēs.	XXI.
22. dŭŏ et vīgintī.	altĕr et vīcēsĭmus (or vīcēsĭmŭs altĕr).	vīcēnī bīnī.	bĭs et vīcĭēs.	XXII.
28. dŭŏdētrīgintā.	dŭŏdētrīcēsĭmŭs.	dŭŏdētrīcēnī.	dŭŏdētrīcĭēs.	XXVIII.
29. undētrīgintā.	undētrīcēsĭmŭs.	undētrīcēnī.	undētrīcĭēs.	XXIX.
30. trīgintā.	trīgēsĭmŭs.	trīcēnī.	trīcĭēs.	XXX.
40. quădrāgintā.	quădrāgēsĭmŭs.	quădrāgēnī.	quădrāgĭēs.	XL.
50. quinquāgintā.	quinquāgēsĭmŭs.	quinquāgēnī.	quinquāgĭēs.	L.
60. sexagintā.	sexāgēsĭmŭs.	sexāgēnī.	sexāgĭēs.	LX.
70. septŭāgintā.	septŭāgēsĭmŭs.	septŭāgēnī.	septŭāgĭēs.	LXX.
80. octōgintā.	octōgēsĭmŭs.	octōgēnī.	octōgĭēs.	LXXX.
90. nōnāgintā.	nōnāgēsĭmŭs.	nōnāgēnī.	nōnāgĭēs.	XC.
99. undēcentŭm.	undēcentēsĭmŭs.	undēcentēnī.	undēcentĭēs.	XCIX.
100. centum.	centēsĭmŭs.	centēnī.	centĭēs.	C.
101. centum et ūnŭs.	centēsĭmŭs et prīmŭs.	centēnī singŭlī.	centĭēs et sĕmĕl.	CI.
200. dŭcentī, -æ, -ă.	dŭcentēsĭmŭs.	dŭcēnī.	dŭcentĭēs.	CC.
300. trĕcentī.	trĕcentēsĭmŭs.	trĕcēnī.	trĕcentĭēs.	CCC.
400. quădringentī.	quădringentēsĭmŭs.	quădrigēnī.	quădringentĭēs.	CD.
500. quingentī	quingentēsĭmŭs.	quingēnī.	quingentĭēs.	D.
600. sexcentī.	sexcentēsĭmŭs.	sexcēnī.	sexcentĭēs.	DC.
700. septingentī.	septingentēsĭmŭs.	septingēnī.	septingentĭēs.	DCC.
800. octingentī.	octingentēsĭmŭs.	octingēnī.	octingentĭēs.	DCCC.
900. nongentī.	nongentēsĭmŭs.	nongēnī.	nongentĭēs.	CM.
1,000 millĕ.	millēsimŭs.	singŭlă mīlĭă.	millĭēs.	M.
2,000 dŭŏ mīlĭă.	bis millēsĭmŭs.	bīnă mīlĭă.	bis millĭēs.	MM.
100,000 centum mīlĭă.	centĭēs millēsĭmŭs.	centēnă mīlĭă	centĭēs millĭēs.	$\overline{\text{CCCIↃↃ}}$.
1,000,000 dĕcĭēs centum mīlĭă.	dĕcĭēs centĭēs millēsĭmŭs.	dĕcĭēs centēnă mīlĭă.	dĕcĭēs centĭēs millĭēs.	$\overline{\text{CCCCIↃↃↃↃ}}$.

* **Altĕr** is used (or *other* or the *second* of two), **secundus** (or *second* of a larger number).

(2) With numeral adverbs to express multiplication, as **bis bina quattuor sunt**, *twice two are four.*

(3) With plural substantives having a singular meaning, as **bīnă** (or **trīnă**) **castră**, *two* (or *three*) *camps*, **bīnae** (or **trīnae**) **aedēs**, *two* (or *three*) *houses*. **Dŭŏ** (or **trĭă**) **castră** would mean *two* (or *three*) *forts*, and **dŭŏ** (or **trēs**) **aedēs**, *two* (or *three*) *temples*. In this particular use **ūnī** and **trīnī** take the place of the more usual **singŭlī** and **ternī**.

Key to Exercise 3

1. He has great love for his country. 2. There are many doves in the woods and eagles in the mountains. 3. The lion is the king of beasts. 4. There are many flowers in the island and many trees on the mountain. 5. Sparrows often sing in the branches of the trees. 6. Art is long, life is short. 7. The pilot stands in the stern of the ship. 8. Man is a prudent and wise animal. 9. The voice of the people is the voice of God. 10. The children of brave men are brave and wise.

1. Non multae in insula urbes sunt. 2. Amor populi sui regi sapienti gratus est. 3. In altis montibus Italiae magna est copia arborum. 4. Hominum corpora mortalia sunt, animi immortales. 5. Sunt mihi multi peregrini servi. 6. Omnis Gallia in tres partes divisa est. 7. Pater et mater fortes fortiores natos habent. 8. Diligentes pueri literas amant. 9. Hortus patris tui fertilis est. 10. Est sorori tuae dulcis vox.

E. A. B.

FRENCH.—V

Agreement.—We have seen that the adjective agrees in number and gender with the substantive that it qualifies. An adjective qualifying two or more singular substantives of the same gender assumes the gender of the substantives, and is put in the plural; thus—

L'arbre et son fruit sont beaux.	*The tree and its fruit are fine.*
La plante et sa fleur sont belles.	*The plant and its flower are fine.*

An adjective qualifying two or more substantives of different genders is put in the plural masculine, as in—

Mon frère et ma sœur sont contents.	*My brother and sister are pleased.*

Place of the Adjective.—The adjective usually follows the noun in French, thus—

Vous avez des amis fidèles.	*You have faithful friends.*

A few common adjectives precede the nouns they qualify. Among these are **beau**, **gros**, **joli**, **jeune**, **méchant**, **sot**, **vieux**. Examples :—

Nous avons de belles maisons.	*We have fine houses.*
Votre jolie petite fille est studieuse.	*Your pretty little girl is studious*

Thus, also, adjectives used in a figurative sense—

une brûlante pénombre.	*a burning half-shade.*
une énorme volière.	*an enormous bird-cage.*

Some adjectives have a different meaning according to their position before or after the noun. Examples :—

Un bon homme, *a simple* or *naive man.*	un homme bon, *a kind* or *good man.*
un brave homme, *a worthy* or *honest man.*	un homme brave, *a brave man.*
le dernier venu, *the one that came last.*	l'année dernière, *last year*
un grand homme, *a great man.*	un homme grand, *a tall man.*
un honnête homme, *a polite man.*	un homme honnête, *an honourable man.*
un pauvre homme, *a poor worthless sort of man.*	un homme pauvre, *a poor* or *needy man.*
une triste chose, *a paltry thing.*	une chose triste, *a mournful thing.*
un vrai diamant, *a real diamond.*	une histoire vraie, *a true story.*
un vrai fripon, *a regular rascal.*	

Comparison.—Adjectives, and also adverbs, form their comparative in French with the few exceptions enumerated below, by means of the adverb **plus**, *more*; thus—

plus beau, plus souvent, *handsomer, oftener.*

The superlative is formed by prefixing the definite article (or a pronominal adjective such as **ton**, **ce**, etc.) to the comparative form; thus—

Votre neveu est le plus savant de tous.	*Your nephew is the most learned of all.*
C'est mon plus grand malheur.	*This is my greatest misfortune.*
l'espèce la plus intelligente et la plus commune.	*The most intelligent and commonest species.*

The exceptions are :—

The adjectives **bon**, **mauvais**, **petit**, and the corresponding adverbs, have irregular comparatives derived from the Latin adjectives **melior**, *better*, **peior**, *worse*, **minor**, *less*, and adverbs **melius**, *better*, **pis**, *worse*, **moins**, *less*. **Beaucoup** has the comparative **plus**, also of Latin origin. These adjectives and adverbs may be tabulated thus :—

Adjectives

Positive.	*Comparative.*	*Superlative.*
bon, *good.*	meilleur, *better.*	le meilleur, *the best.*
mauvais, *bad.*	pire, *worse.*	le pire, *the worst.*
petit, *little.*	moindre, *less.*	le moindre, *the least.*

Adverbs

bien, *well.*	mieux, *better.*	le mieux, *the best.*
mal, *badly.*	pis, *worse.*	le pis, *the worst.*
peu, *little.*	moins, *less.*	le moins, *the least.*
beaucoup, *much.*	plus, *more.*	le plus, *the most.*

When two things are compared the conjunction **que** follows the comparative adjective, thus—

Il est plus docile que son frère.	*He is more docile than his brother.*

The adverb **plus** gives the comparative expressing superiority. To express inferiority the adverb **moins**, *less*, is placed before the adjective or adverb, and to express equality, the adverb **aussi**, *as*, the conjunction **que**, *than*, following the adjective or adverb. Examples :—

il est moins poli que son cousin.	*He is less polite than his cousin.*
aussi aimé que son frère.	*As much loved as his brother.*

The adverbs **autant**, *as much*, **plus**, *more*, **moins**, *less*, **tant**, *so much*, *so many*, are similarly used with the preposition **de** before each of the substantives denoting the things or persons compared ; thus—

autant de crayons que de plumes.	*As many pencils as pens.*
plus de bonté que de jugement.	*More goodness than judgment.*
Il n'a pas tant de courage que de patience.	*He has not so much courage as patience.*
Avez-vous autant de livres anglais que de livres italiens ?	*Have you as many English books as Italian books ?*
J'en ai tout autant.	*I have just as many.*

The adverb **si**, *so*, is often used instead of **aussi** in negative sentences, as in—

Vous n'êtes pas si grand que votre sœur.	*You are not so tall as your sister.*

Très, **fort**, **bien**, etc., all mean *very* when placed before the adjective. This expresses the absolute superlative without comparison between different things. Examples :—

ces chandelles sont très utiles.	*These candles are very useful.*
notre tailleur est bien obligeant.	*Our tailor is very obliging.*

Note the distinction between the absolute superlative **très bon**, *very good*, and the relative superlative **le meilleur**, *the best*.

The adverb **encore**, *still*, is used elliptically in affirmative and negative sentences in the sense of *more*, *any more*, *still more*, as in—

avez-vous encore du café ?	*Have you any more coffee ?*
j'ai encore du café.	*I still have some coffee.*
j'en ai encore.	*I have some left.*

VOCABULARY

admirait (he or she), *admired.*	le maçon, *the mason.*
l'assiette (f.), *the plate.*	la mante, le manteau, *the cloak.*
atroce, *atrocious.*	le manuscrit, *the manuscript.*
aussi bien que, *as much as.*	méchant, *wicked, villainous.*
barbare, *barbarous.*	la mine, *the mien, the bearing.*
bizarre, *bizarre.*	l'objet (m.), *the object.*
charmant, *charming.*	obligeant, *obliging.*
combien, *how much.*	par, *by.*
complaisant, *obliging.*	la piastre, *the dollar.*
connaisseur, *expert, knowing.*	le plat, *the dish.*
le crédit, *credit.*	le poëte, *the poet.*
l'ennemis (m.), *the enemy.*	la plante, *the plant.*
enveloppé, *enveloped.*	rehaussé, *enhanced.*
extraordinaire, *extraordinary.*	souvent, *often.*
la façon, *way, fashion.*	la tête, *the head.*
fort, *very.*	le velours, *the velvet.*
le fruit, *the fruit.*	vit (he or she), *saw.*
le légume, *the vegetable.*	

Exercise 7

1. Le père et la mère sont très aimables. 2. Donnez-moi des robes et des souliers nouveaux. 3. C'est une étrange chose. 4. Victor était un jeune poëte de la ville. 5. Mon fils et ma fille sont très contents. 6. Vous êtes un sot enfant. 7. Nous avons une jolie petite maison. 8. Jamais il n'avait vu de tête plus extraordinaire et plus belle. 9. Il vit une grande personne enveloppée d'une mante de velours noir. 10. Elle admirait les moindres objets avec un petit air connaisseur. 11. Il est un vrai barbare. 12. La façon la plus simple et la plus naturelle. 13. Elle avait une charmante mine, rehaussée par son costume bizarre. 14. Cet atroce animal est fort jaloux. 15. Il est un homme brave aussi bien qu'un vrai fripon. 16. Je l'ai vu souvent l'année dernière. 17. Donnez-le moi, c'est un vrai diamant.

Exercise 8

1. He is as happy as you. 2. Have you more plates than dishes ? 3. Is he more obliging than his brothers ? 4. Has the gardener fewer vegetables than fruits ? 5. He has fewer books than manuscripts. 6. I have no more books. 7. I have no chocolate left. 8. I have but few friends. 9. Your merchant is very obliging. 10. That is the best of those boys. 11. We have some friends left. 12. You still have credit. 13. Have you a dollar left ? 14. Has the mason more bricks ? 15. He has no more bricks. 16. I have but few books. 17. How many dollars have you left ? 18. I have no money left, but I still have credit. 19. Has he as much bread as cheese ? 20. Has he as many friends as enemies ?

Key to Exercise 4

1. Avez-vous le bas de laine ? 2. Non, monsieur, nous avons le bas de soie. 3. La sœur du médecin a une robe de soie. 4. La frère de la dame a un chapeau de soie. 5. Monsieur, avez-vous le livre du médecin ? 6. A-t-il le livre de la dame ? 7. Votre frère a-t-il chaud ? 8. Il n'a ni froid ni chaud. 9. Votre sœur a-t-elle faim ou soif ? 10. Elle n'a pas faim, mais elle a soif. 11. Votre ami a-t-il sommeil ? 12. Mon ami n'a pas sommeil. 13. Ma sœur n'a pas peur. 14. Avez-vous raison ou tort ? 15. Je n'ai jamais honte. 16. Avez-vous du lait ou du vin ? 17. Avez-vous de beau drap et de bon café ? 18. Nous n'avons vu ni arbre ni jardin. 19. Le tailleur a-t-il un bouton d'or ? 20. Le marchand a des chapeaux, de la soie, et du drap. E. A. B.

GERMAN.—II

The verb haben (hahbən), *to have.*

Present Indicative

Sing.	
Ich habe (hahbə)	*I have*
er, sie, es hat (hat)	*he*, etc., *has*
Plur.	
wir haben	*we have*
Sie haben	*you have*
sie haben	*they have*

Preterite Indicative

Sing.	
ich hatte (hattə)	*I had*
er hatte	*he had*
Plur.	
wir hatten (hattən)	*we had*
Sie hatten (hattən)	*you had*
sie hatten (hattən)	*they had*

Examples of negative and interrogative forms: Habe ich? Er hat nicht. Hatten wir nicht? Sie hatten. Es hatte nicht. Haben Sie?

Exercise 3

1. Hatte ich? 2. Wir haben nicht. 3. Hat es nicht? 4. Sie haben nicht. 5. Sie hat. 6. Sie hatte nicht. 7. Sie hatten nicht. 8. Haben sie? 9. Haben Sie? 10. Have we? 11. Had you not? 12. They have not. 13. She has. 14. It had. 15. We had not. 16. Have you? 17. He has not.

The following adjectives—**dieser** (deezər), *this*, **jener** (yaynər), *that*, **jeder** (yaydər), *each*, *every*, **welcher** (velchər), *which*, and **mancher** (manchər), *many a*—are declined like the definite article, except that the nom. and acc. neut. sing. end in **es** instead of **as**.

Thus, sing. mas. dieser (deezər), fem. diese (deezə), neut. dieses (deezəs); plur. diese, etc.

Declension of Nouns

There are three declensions of nouns in German, the strong, the weak, and the mixed.

Nouns of the strong declension, if they are mas. or neut., form the gen. sing. by adding **es** or **s**.

Nouns of the weak declension, if they are mas., take the termination **en** or **n**.

All fem. nouns remain unchanged in the sing.

The dat. plur. of all nouns ends in **n**.

Nouns of the mixed declension form some of their cases according to the strong, and some according to the weak declension.

Strong Declension.—Class 1.—Nouns of the first class form the nom. plur. without adding any termination to the nom. sing., but some modify the vowel of the stem.

To this class belong all mas. and neut. nouns ending in **el, er, em, en, chen, lein, sel**; all neut. nouns beginning with the prefix **ge** and ending in **e**; and two fem. nouns in **er**.

EXAMPLES

	Sing.	*Plur.*
Nom.	der Vater (fahtər), *the father*	die Väter (faytər), *the fathers*
Gen.	des Vaters	der Väter
Dat.	dem Vater	den Vätern
Acc.	den Vater	die Väter

	Sing.	*Plur.*
Nom.	der Wagen (vahgən), *the carriage*	die Wagen, *the carriages*
Gen.	des Wagens	der Wagen
Dat.	dem Wagen	den Wagen
Acc.	den Wagen	die Wagen

	Sing.	*Plur.*
Nom.	das Mädchen (maydchən), *the girl*	die Mädchen, *the girls*
Gen.	des Mädchens	der Mädchen
Dat.	dem Mädchen	den Mädchen
Acc.	das Mädchen	die Mädchen

	Sing.	*Plur.*
Nom.	die Mutter (muttər), *the mother*	die Mütter (müttər), *the mothers*
Gen.	der Mutter	der Mütter
Dat.	der Mutter	den Müttern
Acc.	die Mutter	die Mütter

Masculines.—Only 21 nouns of this class take the modification in the plural.

Apfel (apfəl), *apple.*
Acker (akər), *field.*
Boden (bohdən), *ground.*
Bogen (bohgən),* *arch.*
Bruder (broodər), *brother.*
Faden (fahdən), *thread.*
Garten (gahrtən), *garden.*
Graben (grahbən), *ditch.*
Hafen (hahfən), *port.*
Hammer (hammər), *hammer.*
Laden (lahdən),† *shop.*
Mangel (mangəl), *lack.*
Mantel (mantəl), *cloak.*
Nagel (nahgəl), *nail.*
Ofen (ohfən), *stove, oven.*
Sattel (zattəl), *saddle.*
Schaden (shahdən), *damage.*
Schnabel (shnahbəl), *beak.*
Schwager (shvahgər), *brother-in-law.*
Vater (fahtər), *father.*
Vogel (fohgəl), *bird.*

One noun ending in **e** belongs to this class, der Käse (kayzə), *the cheese.*

Neuters.—Only one noun of this class modifies in the plural, namely, das Kloster (klohstər), *the monastery, convent*, plur. Klöster (klöstər). **Chen** and **lein** are diminutive terminations and are always neuter. If the stem vowel is a, o, u, au, it is modified.

Feminines.—Only one other feminine besides Mutter belongs to this class, namely, Tochter (toktər), *daughter*, plur. Töchter (töchtər).

* Bogen, *a sheet* (of paper), and † Laden, *shutter*, do not modify in the plural.

The Indefinite article *a, an.*

	Mas.	*Fem.*	*Neut.*
Nom.	ein (yn)	eine (ynə)	ein
Gen.	eines	einer	eines
Dat.	einem	einer	einem
Acc.	einen	eine	ein

VOCABULARY

Gärtner (gertnər), mas., *gardener.*	Spaten (shpahtən), mas., *spade.*
Schüler (shülər), mas., *pupil.*	Lehrer (layrər), mas., *teacher.*
Wetter (vettər), neut., *weather.*	Leben (laybən), neut., *life.*
schön (shön), *beautiful.*	schlecht (shlecht), *bad.*
gut (goot), *good.*	in (inn), *in.*

The prep. **in** governs the dat. case when it indicates rest at a place, and the acc. case when it indicates motion towards a place.

Exercise 4

1. Der Vater iſt ein Mann und die Mutter iſt eine Frau. 2. Wer iſt dieſer Mann? Er iſt der Onkel jener Frau. 3. Was hat das Kind? Es hat einen Spaten. 4. Wo ſind die Schüler? Sie ſind in dem Garten. 5. Das Wetter war geſtern ſchön; es iſt heute ſchlecht. 6. Der Schüler dieſes Lehrers iſt gut. 7. Wo waren die Gärtner? Sie waren unten. 8. Ich gebe dem Bruder einen Spaten. 9. Der Onkel iſt in einem Kloſter. 10. Wer ſind jene Mädchen? Sie ſind Töchter dieſer Frau. 11. Das Leben in dem Gebirge iſt ſchön. 12. Dieſes Mädchen hat einen Vater, eine Mutter und einen Bruder.

Exercise 5

1. Who is that child? It is the daughter of this woman. 2. Where is the gardener? He is upstairs. 3. This man is the teacher of those pupils. 4. The mountain range is there. 5. The brothers of that woman are in a monastery. 6. Is the weather fine to-day? 7. The father was here, but the mother was never here. 8. That man had gardeners. 9. These girls have an uncle. 10. He is the brother of those girls. 11. Had you a spade? 12. We were in the garden.

The following Possessive Adjectives are declined like the Indef. Art. "ein":—

mein (myn), **meine**, **mein**, *my.*
dein (dyn), **deine**, **dein**, *thy.*
sein (zyn), **seine**, **sein**, *his.*
ihr (eer), **ihre**, **ihr**, *her* or *their.*
Ihr (eer), **Ihre**, **Ihr**, *your.*
unser (unzər), **unsere**, **unser**, *our.*
euer (oyər), **euere**, **euer**, *your.*

The forms dein and euer correspond to the sing. and plur. of the 2nd pers. pron. **du** and **Ihr.**

Note that the form Ihr, which corresponds to the 2nd pers. pron. Sie, is always written with a capital.

In the same way is declined the adj. **kein** (kyn), *no, not any.* In the plur. these words are declined like the Def. Art.

	Singular			*Plural,*
	Mas.	*Fem.*	*Neut.*	*all Genders.*
Nom.	kein	keine	kein	keine
Gen.	keines	keiner	keines	keiner
Dat.	keinem	keiner	keinem	keinen
Acc.	keinen	keine	kein	keine

VOCABULARY

einmal (ynmahl), *once.*	zwei (tsvy), *two.*
Rasen (rahzən), mas., *lawn, turf.*	grosz (grohss), *great, big.*
klein (klyn), *small, little.*	hübsch (hübsh), *pretty.*
er arbeitete (arbytətə), *he worked.*	sie spielten (shpeeltən), *they played.*
	auf (owf), *on.*

Exercise 6

Es war (1) einmal ein Mann. Er hatte eine Frau (2) und zwei Töchter. Die Frau war ſchön, der Mann war groß aber er war nicht ſchön. Die Töchter waren klein und hübſch. Der Mann war Gärtner und hatte einen Garten. In dem Garten waren Äpfel und Gemüſe und auch ein Raſen. Auf dem Raſen waren Vögel; dieſe Vögel waren klein. Der Mann arbeitete in dem Garten und ſeine Frau und ſeine Töchter ſpielten dort.

NOTES:—

(1) Es war means literally it was, and is equivalent to there was. (2) Frau means wife as well as woman.

Answer the following in German:—

EXAMPLE:—

Wie (vee) war der Mann? Er war grosz aber nicht schön.

i.e. How (of what kind) was the man? He was big but not beautiful.

Exercise 7

Wie war ſeine Frau? Wie waren ſeine Töchter? Was war der Mann? Was war in dem Garten? Was hatte der Mann? Was war auf dem Raſen? Wie waren die Vögel? Wo war der Mann? Wer war auch da?

Infinitives used as nouns are all neuter, and follow the declension of the neuter nouns of the first class of the strong declension.

Strong Declension.—Class 2.—Nouns of the second class form the nom. plur. by adding **e**; at the same time the stem vowel is modified, as a rule, but there are a good many exceptions to this. To this class belong:

All mas. nouns of one syllable; all mas. nouns ending in **ich**, **ig**, **ling**; nouns of foreign origin ending in **al**, **an**, **ar**, **ast**, **at**, **ier**, **or**, **on**, which are accented on the last syllable.

Many neuter nouns.

About thirty monosyllabic fem. nouns (which, however, of course do not change at all in the sing.), and also their compounds, as well as the compounds of **kunft**, which is not used as an independent word;

also about a dozen ending in the suffix **nis** and two or three in **sal**.

Mas. and neut. nouns form the gen. sing. by adding **es** or **s**. As a rule monosyllables take **es** and nouns of more than one syllable take **s**, but in colloquial German **s** is mostly used. Words that end in a sibilant (**s** or **z**) must take **es**. Those ending in **t** and also in **g** (which is frequently pronounced **ch** or **k**) and **ch** nearly always form the gen. sing. in **es**. The forms in **es** should always be used in serious writing.

Mas. and neut. nouns of one syllable and a few of more syllables form the dat. sing. by adding **e**, but this **e** may always be omitted and, like the longer form of the gen. sing., is chiefly used in a literary style.

All the fem. nouns, except those ending in **nis** and **sal**, modify in the plural.

EXAMPLES

	Sing.	*Plur.*
Nom.	der Sohn (sohn), *the son*	die Söhne (sönə) *the sons*
Gen.	des Sohnes	der Söhne
Dat.	dem Sohne	den Söhnen
Acc.	den Sohn	die Söhne

	Sing.	*Plur.*
Nom.	der Monat (mohnaht), *the month*	die Monate, *the months*
Gen.	des Monats	der Monate
Dat.	dem Monat	den Monaten
Acc.	den Monat	die Monate

	Sing.	*Plur.*
Nom.	das Brot (broht), *the bread* or *loaf*	die Bröte (brötə), *the loaves*
Gen.	des Brotes	der Bröte
Dat.	dem Brote	den Bröten
Acc.	das Brot	die Bröte

	Sing.	*Plur.*
Nom.	die Hand (hant), *the hand*	die Hände (hendə), *the hands*
Gen.	der Hand	der Hände
Dat.	der Hand	den Händen
Acc.	die Hand	die Hände

Das Jahr (*y*ahr) is declined like Brot, but does not modify in the plur.; nom. plur., die Jahre.

Die Ersparnis (ayrshpahrnis), *the saving*, is declined like die Hand, but does not modify in the plur.; nom. plur., die Ersparnisse.

Note that nouns ending in **nis** double the **s** before adding the termination.

VOCABULARY

Erzäh'lung (ayrtsay'lungk), *tale, story.*
er kam (kahm), *he came.*
Schlacht (shlak*t*), fem., *battle.*
er beglück'wünschte (beglück'vünshtə), *he congratulated.*
Krähe (krayhə), fem., *crow.*
heil (hyl), *hail.*
er bewun'derte (bəvun'dertə), *he admired.*
Papagei' (papagy'), mas., *parrot.*
denn (den), *for*, conj.
Grusz (groos), mas., *greeting.*
er lebte (layptə), *he lived.*
da'mals (dah'mahls), *at that time.*
arm (arm), *poor.*
er lernte (layrntə), *he learnt.*
er wurde (voordə), *he became.*
dann (dann), *then.*
Mühe (mühə), fem., *trouble.*
endlich (endlich), *at last.*
er brachte (brahktə), *he brought.*
darauf' (dahrowf'), *thereupon.*
herzlich (hayrtslich), *heartily.*
er gab (gahp), *he gave.*
Geld (gelt), neut., *money.*
andere (andərə), *other.*
nach (nah*k*), *after*, prep. gov. dat.
bei (by), *near, at*, prep. gov. dat.
Kaiser (kyzər), mas., *emperor.*
er sagte (zahgtə), *he said.*
Sieger (zeegər), mas., *conqueror.*
er kaufte (kowftə), *he bought.*
ihn, *him*, pers. pron., mas. acc.
Elster (elstər), fem., *magpie.*
sie sagten, *they said.*
Schuster (shoostər), mas., *cobbler.*
Rom (Rohm), *Rome.*
er lehrte (layrtə), *he taught.*
langsam (langkzam), *slowly.*
müde (müdə), *tired.*
Zeit (tsyt), fem., *time.*
verlor'en (ferlohr'ən), past part., *lost.*
Wort (vort), neut., *word.*
sie, *her*, pers. pron., fem. acc.
er lachte (lak*t*ə), *he laughed.*
er nahm (nahm), *he took.*
viel (feel), *much, many.*
er tat (taht), *he did.*
schnell (shnell), *quickly.*

Exercise 8

Erzählung:—

Ein Mann kam nach der Schlacht bei Actium und beglückwünſchte den Kaiſer; der Mann hatte eine Krähe und der Vogel ſagte, „Heil Kaiſer und Sieger.“ Der Kaiſer bewunderte den Vogel und kaufte ihn. Er kaufte auch einen Papagei und eine Elſter, denn dieſe Vögel ſagten auch den Gruß. Ein Schuſter lebte damals in Rom; der Schuſter war arm, und er lehrte eine Krähe den Gruß. Die Krähe des Schuſters lernte langſam, und der Schuſter wurde oft müde und er ſagte dann, „Meine Zeit und meine Mühe ſind verloren.“ Aber die Krähe lernte endlich die Worte, und der Mann brachte ſie dem Kaiſer. Dieſer aber ſagte, „Ich habe drei Vögel zu Hauſe, ſie ſagen auch dieſe Worte.“ Die Krähe ſagte darauf, „Meine Zeit und meine Mühe ſind verloren,“ und der Kaiſer lachte herzlich, nahm den Vogel und gab dem Schuſter viel Geld.

Exercise 9

1. Was ſagte die Krähe? 2. Was war der Gruß? 3. Hatte der Kaiſer auch andere Vögel? 4. Was ſagten dieſe Vögel? 5. Wo lebte der Schuſter? 6. Lernte die Krähe des Schuſters ſchnell? 7. Wurde der Schuſter müde? 8. Was ſagte er dann? 9. Lernte die Krähe den Gruß? 10. Brachte der Schuſter dem Kaiſer die Krähe? 11. Was ſagte der Kaiſer? 12. Was ſagte darauf der Vogel? 13. Was tat dann der Kaiſer?

Key to Exercise 2

1. Wo sind Sie? 2. Ich bin oben. 3. Ist sie auch da? 4. Nein sie ist unten, aber er ist hier. 5. Wer ist sie? 6. Wo waren sie? 7. Der Mann war hier und das Kind war dort. 8. Ist es hier? Ja. 9. Sind Sie heute zu Hause? 10. Nein, und ich war gestern auch aus. 11. Ist die Frau noch hier? 12. Nein sie ist nie hier. 13. War der Mann zu Hause? 14. Nein er war schon aus. 15. Wir sind immer aus.

M. A. L.

Continued from page 241.

GEOGRAPHY:

Contributors:—Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).

OCEANS AND LAND

THE oceans cover about 71 per cent. of the surface of the earth; land surfaces occupy some 29 per cent. Viewing the globe with New Zealand as centre of the visible hemisphere, we observe that there is very much more water than land. If we take France as a central point, the surrounding hemisphere has very much more land than water.

Using the equator as the dividing line between northern and southern hemispheres, we observe that the southern hemisphere contains only about half as much land as the northern hemisphere.

If it were possible for the earth's surface to be reduced to its average level, the globe would become one great ocean two miles deep. That there is dry land at all is due to those geological accidents which have resulted in parts of the crust being elevated into great folds, while parts have been depressed to form the ocean bed.

Heights and Depths

The mean depth of the ocean is about 11,500 feet; the mean height of the world's land is 2,300 feet. Thus the average depth of the sea (over two miles) is approximately five times the average height of the land. This leads us to the consideration of certain interesting facts with regard to the average elevation of the land in relation to sea depths. Only 6 per cent. of the globe is higher than 3,300 feet; 28 per cent. of it is plain and plateau below 3,300 feet. More than half the crust is over half a mile below sea-level.

The highest mountain is Everest, in the Himalaya (29,000 feet). The deepest ocean abyss is the Planet Deep, south of Mindanao (32,089 feet). There is another famous "deep," which long held the record as the deepest hole in the earth's crust—the Nero Deep (in the Northern-Western Pacific, near the Ladrone or Marianne Islands), which runs to 31,614 feet (5,269 fathoms).

A few miles west of the Andine uplift the ocean bed sinks to "deeps" of 3,000 fathoms or more. Thus one of the world's highest and longest mountain chains is flanked by sea of tremendous depth. The western Pacific, in fact, is the deepest part of the world's seas.

Another interesting point is that although South America has a vaster mountain system than any other continent save Asia, it has 42 per cent. of its area below 600 feet, and only 6 per cent. above 10,000 feet.

The Pacific Ocean

The Pacific, with an area of 63,986,000 square miles, is the largest of the oceans. It got its name from early discoverers and explorers who were fortunate in finding it "the peaceful ocean." The feature we associate with it is the vast number of island groups scattered over its southern and eastern part.

The Atlantic (31,530,000 square miles), less than half the area of the Pacific, takes its name from the vanished continent of Atlantis, which was supposed to have existed where the waters of the North Atlantic now roll fathoms deep. It is interesting, however, to note that the idea has some foundation in geological fact.

The comparative geological structure of Europe and North America suggests the probability of the existence of a considerable land-mass in the North Atlantic in pre-historic times; although we have no evidence that it was inhabited by a cultured race of pyramid and temple builders, as believers in the legend of the lost Atlantis would have us suppose.

The Atlantic, as the ocean highway between the lands of the busiest and most progressive peoples of the world, carries the bulk of the world's sea-borne trade.

The Indian Ocean (28,350,000 square miles) is so named because India was the only

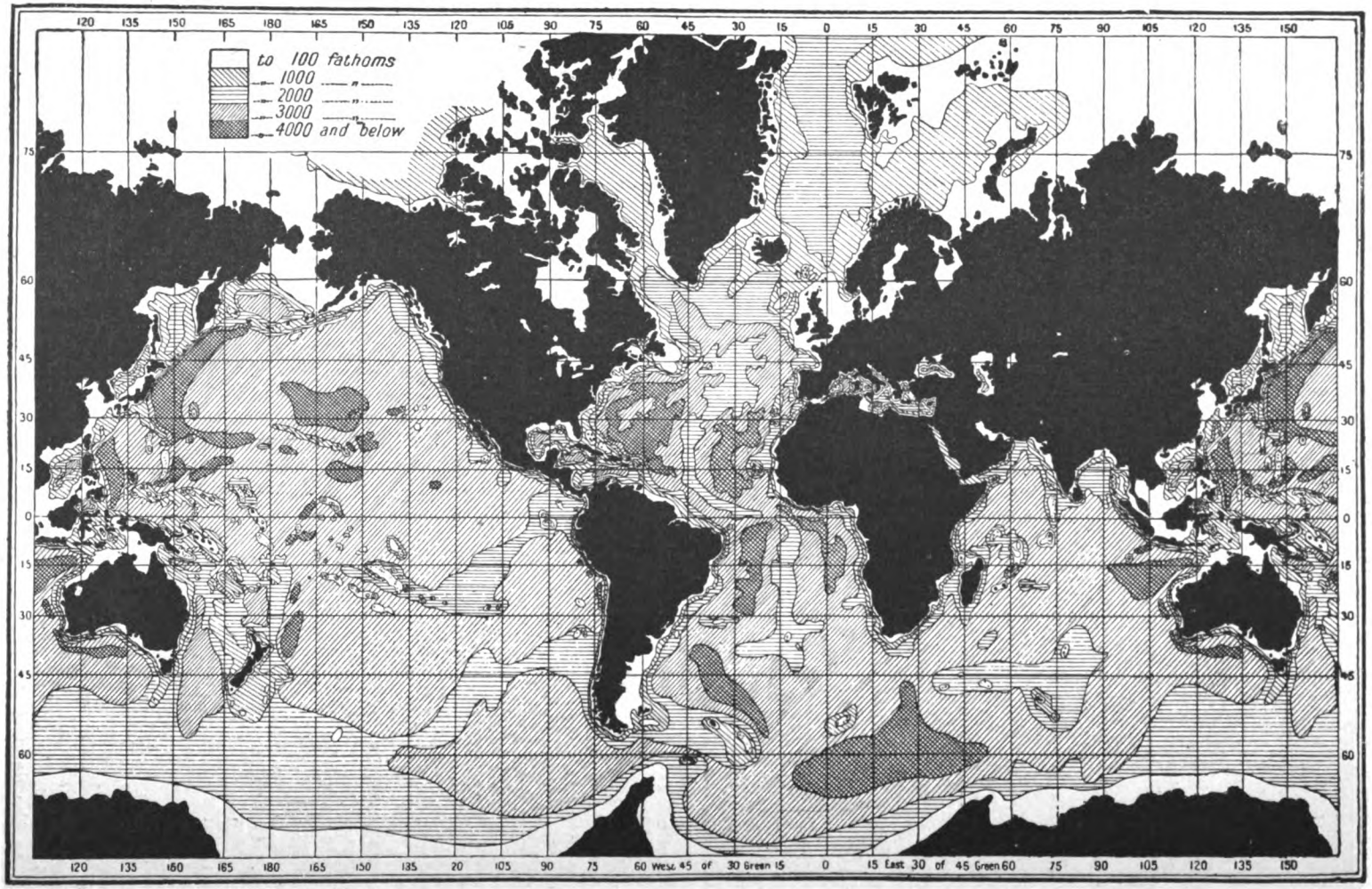


Fig. 17.—Map of the World, showing the varying depths of the sea. The deepest ocean abyss is the Planet Deep (32,089 feet), south of Mindanao, a Philippine Island in the Pacific—longitude 122°–126·5° E., latitude 6°–10° W.

important country known by the ancients to be washed by its waves. To the Portuguese navigators who first ventured across its waters in 1498 it was the waterway to India. Of Africa they knew little; of Australia, nothing at all.

The Arctic Ocean (Greek ἄρκτος=bear) is so called because above it the constellations of the Great and the Little Bear keep their age-long vigil in the zenith. The Antarctic is "opposite" the Arctic. Note that whereas the Arctic is a Polar basin, almost land-locked by the coasts of Asia and North America, the Antarctic is a broad belt of open sea surrounding the island ice-continent of Antarctica.

Continent	*Area in millions of sq. miles.*	*Approx. length of coastline in miles.*	*Population (millions).*
Europe ..	3·76	23,100	451·4
Asia ..	17·1	43,900	950·5
Africa ..	11·28	19,000	128·3
N. America	8·2	46,700	128·9
S. America	7·0	17,800	49·6
Australia ..	3·0	12,100	4·5
Antarctica	3·5 (?)	unknown	uninhabited

The course followed by the 100-fathom line and other ocean-bed contours suggests that all the continents extend, as it were,

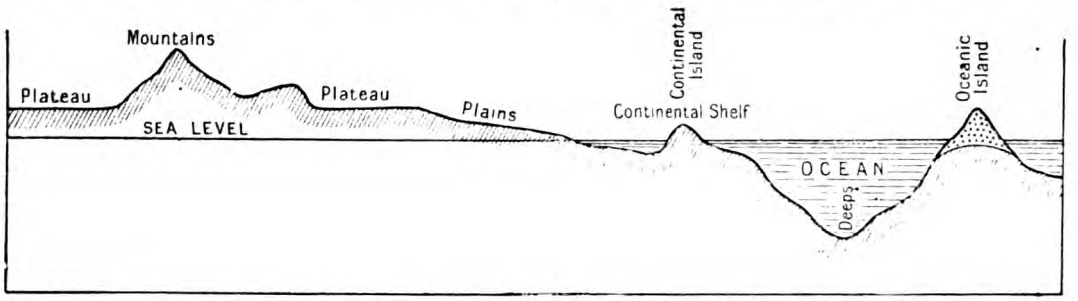


Fig. 18.—Diagram Showing Continental Shelf and Oceanic Island.

Ocean beds extend some distance under water before descending steeply to the ocean abysses.

The continuous belt of ocean south of the continents is often referred to as the great Southern Ocean. This region, between 40° and 50° south latitude, owing to the uninterrupted sea surface right round the globe, is swept by strong westerly winds, known to seamen as "The Roaring Forties." The parts of the South Atlantic, Indian, and Pacific Oceans within this area are always rough and stormy.

Continents of the World

Reference to the globe will make clear how the land-masses are arranged in a huge horseshoe round the great oceans. From Cape Horn round the Pacific to Australia, and from the Cape round the Atlantic to Cape Horn, the continents form an almost continuous land area. Where breaks occur, there were formerly land bridges, as may be seen (1) from the map showing ocean depths (Fig. 17), (2) from geological evidence.

The comparative areas of the continents may roughly be computed as under. Their population and approximate length and coastline are given for purposes of comparison and reference.

some distance under water before descending steeply to the ocean abysses. Here and there this submarine platform, or "Continental Shelf" as it is called, is broad enough for islands to rise from it, e.g. the British Isles, from the European shelf, the East Indies from the Asiatic shelf, and the Falkland Islands from the South American shelf. Such islands are known as "continental islands."

Islands which rise steeply from the ocean depths are called "oceanic islands." They are usually of volcanic origin, are very steep-sided, and are quite isolated from any great land mass. Examples are frequent in the South Pacific.

The science of Astronomy reveals to us the history of the Earth's beginning. It carries the story to the days when the outer crust of the molten semi-plastic sphere began to cool and harden, and under the influence of swift rotation to assume its characteristic geoidal shape.

Chapters of Earth-lore have been written for us by the hand of Nature in the "Book of the Rocks"—in a vast series of volumes whose first pages were made some fifty or sixty million years ago, and whose last pages will be finished when the world itself comes to an end.

All we know of the Earth's history before the coming of man and the making of man's records, we learn from the study of the Earth's crust itself. This crust we know to be made up of materials known as Rocks. A rock (in geology) is any natural substance forming part of the Earth's crust. Certain rocks are arranged in definite layers, and have evidently been deposited as sediments in the sea, in ancient lakes, or in river beds. Such layered rocks are known as Stratified or Aqueous rocks. Other rocks are found in huge shapeless masses, are usually crystalline in texture, and have evidently crystallised from a state of fusion. Such are known as Unstratified or Igneous rocks.

Yet a third type of rock must be considered, if we would know all that is to be learned from the Earth-crust. Some rocks cannot be said to be stratified or unstratified; they have the characteristics sometimes of both, sometimes of neither. They have undergone great changes since their first formation—changes due to pressure, or heat, or both. These rocks are called Metamorphic—rocks that have suffered change.

The "Book of the Rocks" may well be said to be the enormous pile of sediments which go to form the stratified rocks. It is to the stratified rocks we must go if we wish to know what the world was like before the days of man.

The Book of the Rocks has invaluable illustrations. Certain pages in it have what we may regard in our analogy as pictures to elucidate the text. These are Fossils. Strictly speaking, a fossil is any trace of life found in the rocks. It may be a bone or a shell; it may be the cast of a shell, the imprint of a leaf, or even a footprint or a worm-cast.

It is chiefly by the study of the fossils in relation to the rock in which they are found, and in relation to the series in which the rock lies, that we are able to reconstruct scenes in the early history of the earth and its creatures.

It is from fossils that we learn, for instance, that the Negro sub-species of man probably originated from the primitive beginnings of *Homo sapiens*, in Southern or Western Europe. Negroid remains of about thirty or forty thousand years ago—perhaps even more ancient—have been found at a depth of twenty-seven feet below the surface soil of certain caverns on the French Riviera; and somewhat similar remains of less ancient date have been detected in old burial-places in Italy, Western France and Sicily.

The oldest skulls as yet found in the palæolithic fossil-bearing ground of Algeria indicate in the same way a Negro or Negroid type.

R. F.

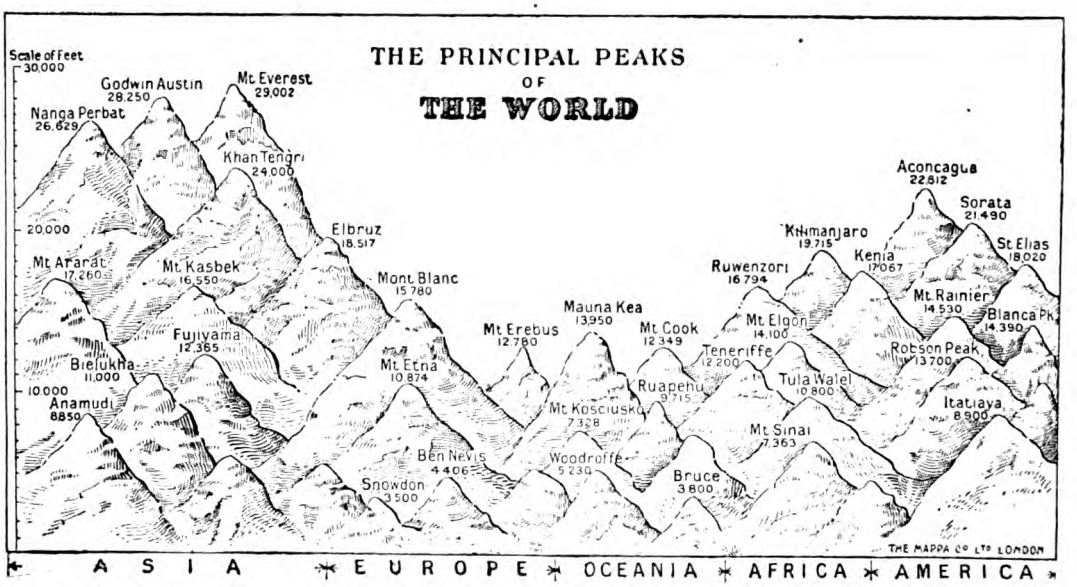


Fig. 19.—Diagram Showing the Principal Peaks of the World.

The highest mountain is Everest, in the Himalaya. The mean height of the world's land is 2,300 feet; the mean depth of the ocean is 11,500 feet; so that if the land were reduced to its average height the globe would be one great ocean two miles deep.

Continued from page 236

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

DRAWING.—IV

BEFORE passing on to other matters, which in themselves may be rather more interesting, but which depend (like the whole fabric of the art) upon the elementary principles, and which without them are incomprehensible, it is just as well to say a little more about Parallel Perspective.

In the first place, bear in mind that horizontal lines at right angles with the picture plane, or, put more simply, lines which in the object before you *go away from you*, are always drawn slanting. Every horizontal line in a drawing slants unless the point of sight comes at about its middle, that is, unless you look at it quite directly. If you stand straight in front of a house the lines of the windows, the door, the roof will all be straight and will be drawn horizontally across the picture. If you stand and look at the house at all sideways—that is, stand so that you see *more* than just the front of it—all the horizontal lines will be retiring. If the corner of the house is the object *immediately* in front of you, the retiring lines on either side will run at about the same angle (*see* Fig. 18); but if you are rather more to one side than to the other, the angles will be wider on the side of which you see more.

But vertical lines are always vertical.

Horizontal or inclined lines can seldom be drawn on paper in the actual physical position which they occupy in reality, that is, in the original object. But perpendicular or vertical lines are always the same on paper as they are in reality.

It is a mistake to suppose that written lessons can teach you everything. Ordinary common sense and hard thinking are highly necessary as well. Rules can be written down; the way to apply rules must nearly always be left mainly to the individual's sense. Parrot-knowledge of the rules without personal experience of trying to put them in practice is quite useless.

Students, particularly young students, are often prone to complain that a list of rules of technical terms is apt to be very dry and uninteresting. So, in a sense, they are. But always remember that dry technical terms are only used for the sake of brevity. They explain in a word or in a few words what in ordinary language might occupy a long sentence. Moreover, they are the result of long study on the part of artists who have sought to tabulate in convenient form, briefly and with point, all their experiences of the difficulties and trials of their art.

By sheer common sense, and common sense alone, it is quite possible that you may teach yourself everything in your own way that you need to know of such complicated subjects as perspective and so on. But think of the time that this process would take! You might possibly have learnt from your own untutored experience *something* about your subject in a couple of years of unremitting work and disappointment. Whereas, by learning the rules and principles which others have laid down from the experience of generations and genera'ions before them, you may well find yourself master, at all events, of the theoretical part of the matter at the end of a week.

In regard to these rules of perspective, you should remember that they apply equally well whether you are drawing from an object, such as a chair, or from the copy of an object, such as someone else's drawing of a chair.

Now turn to Fig. 20, from which may be obtained most excellent practice in perspective. First of all begin by drawing the line of sight, which will be your guide and guard against mistakes. There is no particular reason why you should not *rule* this line, and then you will be sure that, at any rate, you start right. Take care, when doing so, that it is strictly at right angles with the edge of your paper and the edge of your board; that, in fact, it really is an accurately horizontal line. Do this so as to begin well, but never fall into the habit of ruling other lines, however much you may be tempted to do so. If you once start ruling lines which are an integral part of the drawing, you will always be doing it, and then you will never learn properly to control your hand.

Having got your line of sight right, next mark in your point of sight. When you have done this look carefully at the copy before you and mark in on the line of sight the exact position of every line that comes on either side of the P.S. The corner of the wall at the entrance to the passage is one, you will see; the vertical lines of certain stones in the wall are others—*b*, *c*, *d*, *x*. If you make sure of getting the short distances right, it naturally follows that you get the whole distance right. Thus once you have correctly established the distances between the P.S. and *a*, and *a* and *b*, and *b* and *c* and so on, you will rightly gauge the full distance between the P.S. and *x*.

The reason why you should constantly bear in mind that the P.S. is the place to start from, is simply that the spot where your eye naturally rests will be the most easy to observe and to draw from. Therefore, you should invariably begin at the P.S. and with the objects immediately to the left and right of it, and you will make a good beginning to your picture.

To give an instance of the wrong sort of beginning for a drawing, you will often find people, who either have no knowledge or else wilfully neglect the lessons they have been taught, start by drawing one to another and the angle at which their lines lie with regard to the line of sight. Mark in all important lines by degrees as described above, from the vanishing point outwards on either hand.

A further explanation of the *station point* may be given in this way: A man sits with his easel before a house and, having chosen his own point of view, draws the house from that, arranging the retiring lines as *he* sees them. But left and right of him there may be half a dozen others, each drawing the same object, each from a slightly different station point, and therefore each with

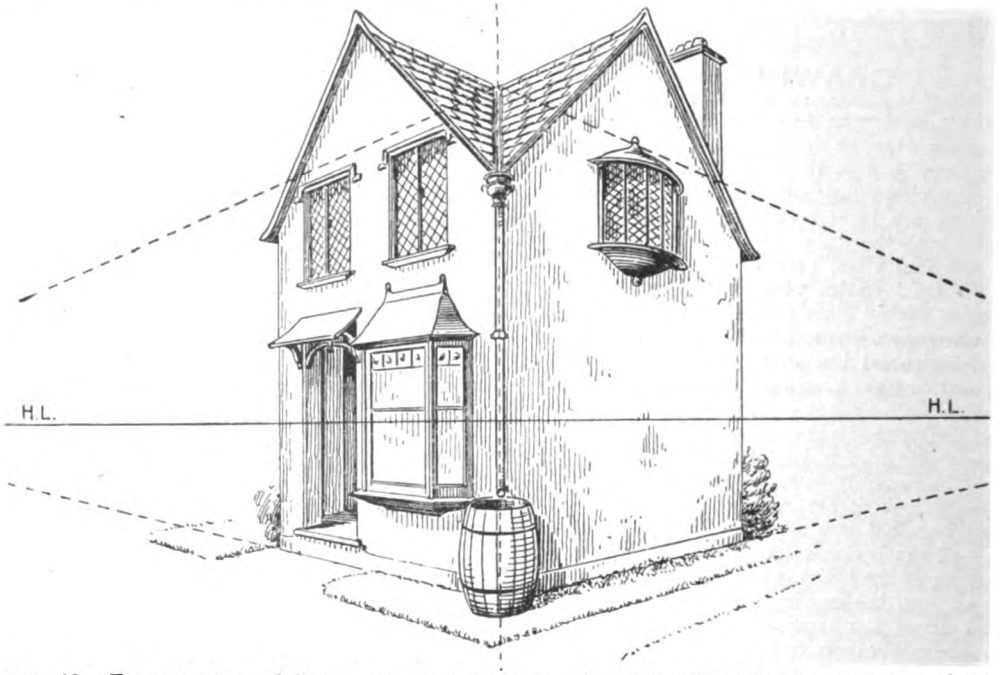


Fig. 18.—Every horizontal line in a drawing slants unless the point of sight comes at about its middle—i.e. unless you look directly at it.

the gables of a building and working gradually downwards till they reach the ground. The result may be easily imagined. By the time the student has reached, say, the lower windows he will find himself in a state of hopeless confusion, with the wh le drawing out of proportion, and the gable with which he originally started either six times too big or six times too small.

The proper method is the only method. Draw first what you most conveniently see and build up the rest upon that. What you most conveniently see is on the line of sight.

You should, after drawing or at least marking in objects on the l'ne of sight, work downwards from that line to the bottom of the picture. This done, work on the upper part, which lies above the level of the eyes. The same principle holds good in the case of any subject. Suppose that you arrange a group of furniture—a table with books and a vase of flowers on it, and a chair by its side. Where are you to begin? Again determine the line of sight. Draw the ob'ects which appear to you the most central in position. Mark in their positions rather different angles for their retiring lines and different perspective altogether. The drawing of each of these may be perfectly accurate, but it will necessarily be different.

It may help a little if the Rule numbered 11 is now explained with the assistance of a practical example. The rule in question laid down that all lines inclined with the horizon and with the picture plane have their vanishing points above or below the line of sight, according to the angle they form with the horizon, their vanishing points being always on a line perpendicular to the vanishing point on the line of sight to which they would have retired if they had been horizontal.

You should now study Fig. 19, which provides a case in point. Here it is the lines *a b* and *c d* on the sides of the roof which are the inclined retiring lines. Supposing you had a flat roof—that is to say, a roof horizontal with the ground plan and with the base of the picture—then the line *c e* would have been the retiring line running towards the P.S. But between one edge of the roof and the other, between, that is, the back

and the front, there is here a considerable difference in elevation—all the difference marked by the line *e* to *d*. So the whole surface or plane of the roof is inclined, and therefore the vanishing point is higher than the P.S. Its height, in fact, varies according to the amount of the slant. Having made sure where the line *e d* lies, you will see, if you continue it, that it cuts a vertical line from the P.S. at some height above the latter. And there is the common vanishing point of *a b* and *c d*. The vanishing point is the same for both, because in reality (though not in appearance on paper) *a b* and *c d* are parallel lines.

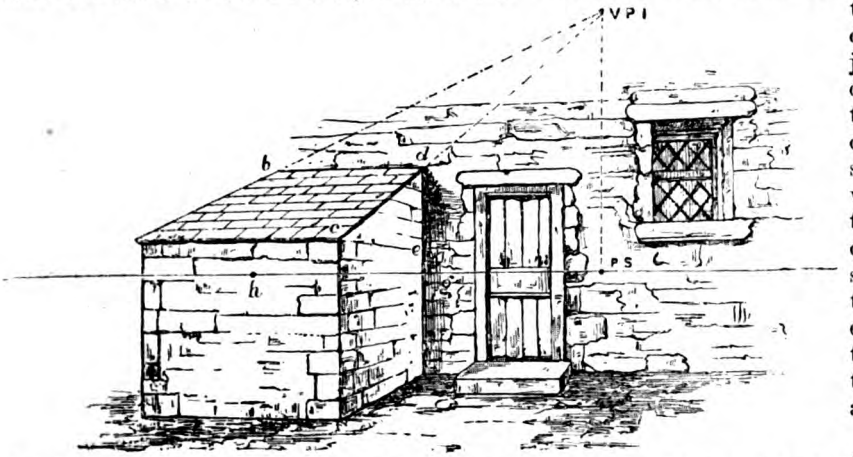


Fig. 19.—Lines inclined with the horizon and with the picture plane have their vanishing points always on a line perpendicular to the vanishing point on the line of sight to which they would have retired had they been horizontal.

Hereabouts you will have to tackle a very difficult problem in drawing, that of the measurement of lines by eye. In all probability it is the simple fact that you know a line to be, say, a foot long in reality, which makes it difficult for you to represent it on paper as less than a foot long. A retiring line, particularly when the angle is sharp, is very much shorter, of course, when rightly drawn in perspective than it is in reality. And this you must remember when copying. Never on any account measure your line on the copy and then on your drawing. It is just as bad a mistake as that already referred to—ruling it. If you use a measure you do not train your eye. And it is the training of the eye, helped and indeed persuaded by the reasoning faculty, which is so entirely indispensable to good work. The vanishing point which you have determined and marked yourself should prove an all-sufficient guide for your purpose. If you have got that right you will be able to make everything else more or less dependent on it; and if you take great pains in marking out distances (which is so *very* important) you will get the framework of your drawing sound.

It is useful to remember that all the rules and hints which have been given in the last two lessons have one supreme object. They are designed to help the student to overcome the irresistible tendency which we all have to see things more or less in their real shape and not as they appear to the eye. In short it is to distinguish between appearance and reality.

This is, strangely enough, a problem in philosophy as well as in art. Only the philosopher aims at eliminating appearance as deception, while the artist fulfils his purpose when he has got himself away from *what is* and portrays *what appears*. The philosopher looks for reality behind the appearance.

J. G .B. L.

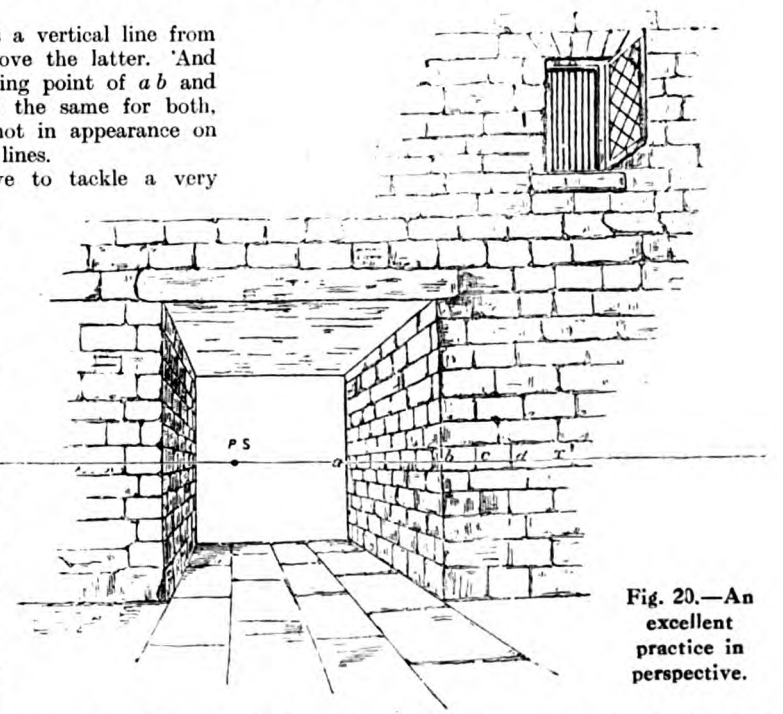


Fig. 20.—An excellent practice in perspective.

CHALK STUDIES

CHALK studies for paintings on tinted paper or otherwise have a most peculiar fascination. This fascination is three-fold. Firstly, if the drawing is good in itself, it compels admiration in the ordinary way of good drawings. Secondly, the mere fact that it is a study, a rough sketch possibly with stress laid upon, and care particularly taken of, one of its many features, provides an interest outside the excellence of the actual work. Thirdly, there is often a sentimental interest in a study, which when you look at it you know to be a great artist's practice work for some picture you happen to know and are peculiarly fond of.

For an accomplished artist to make studies of any particular features in a picture that he is about to work upon is much on the same plane of action as the advanced student who does not disdain to make the fullest use of the A B C of elementary drawing. The student can, we will say, really control his hand and has an already practised eye. Yet he does not consider it beneath him to mark his distance for the true placing of lines. Unfortunately a great number of artists (and it must be admitted good ones amongst them) do not trouble to make studies. Of these the late Lord Leighton, P.R.A., was not one. Most diligently he made studies for all his pictures. To quote the words of a contemporary critic: "Sir Frederick" (as he was then) "is a model to all artists in one very rare virtue, that of submitting himself patiently, in his age, to the same discipline which strengthened him in youth."

The reader may see in the accompanying illustration a fine study for drapery. There were few things in which Lord Leighton took a greater interest or a keener pleasure than in draped figures, and he was indeed a past-master in this most difficult field. It is not merely that he was so absolutely true in sheer drawing and proportion—he was, and that goes without saying—but he had a wonderfully accomplished knack (though knack is a flippant word to use in such a regard) for suggesting the texture of the material of which the drapery consists. In the study before us, we see a woman of a high classical standard of physical beauty, draped in clinging folds of soft material. This reveals the lines of her body, and yet flows and falls like water from her shoulders and from her knees. The paper used is tinted. Many artists make their chalk studies on ordinary brown paper, and this if it is not of too dark a tone is a perfect background for black and white chalk. In this drawing, the face and arms are not rendered in any way in a finished manner. They are merely suggested, but suggested correctly. It is the drapery that matters here. The high lights are made with a liberal use of white chalk. Notice particularly the extreme delicacy of the falling robe about the figure's feet. This and the folds over her body beneath the breast is a masterpiece of exquisite and delicate craftsmanship.

From the Picture by Lord Leighton P.R.A.

THE SPIRIT OF THE SUMMIT.

A characteristic sketch by one of the greatest English masters of the draped figure.

No one except a master in the art can hope for fine effects in depicting drapery. Unlike the human body, with its delicate supple lines, forming in itself a beautiful study, the folds of robes and dresses do not fall naturally into harmonious figures. To prevent a heavy, bulky effect is extremely difficult. In the case of sculpture such bad effects can hardly be avoided. At the Musée de Luxembourg, Paris, there are statues in coloured marble of women wearing long robes, and their unpleasing congealed effect is plain to any one. It is a relief to turn, in the same hall, to the almost living beauty of studies in the nude. J. G. B. L.

Continued from page 248

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—V

39. A common multiple of two or more given numbers, is any number which is exactly divisible by each of the given numbers. Or in other words, a common multiple of two or more given numbers is any number of which each of the given numbers is a factor. Thus, 36 is a common multiple of 2, 3, 6, 12 and 18.

The **Least Common Multiple** of two or more given numbers is the least (or smallest) number which is exactly divisible by each of the given numbers.

Thus, 60 is the L.C.M. (Least Common Multiple) of 2, 5, 6 and 12.

40. To find the L.C.M. of any numbers which can easily be resolved into prime factors, we proceed as follows:

(1) To find the L.C.M. of 12 and 18.

$12 = 4 \times 3 = 2^2 \times 3$

$18 = 2 \times 9 = 2 \times 3^2$

Every multiple of 12 must contain 2^2 and 3 as factors.

Every multiple of 18 must contain 2 and 3^2 as factors.

Since 2 is a factor of 2^2, and 3 is a factor of 3^2, it is obvious that any number which contains 2^2 and 3^2 as factors, also contains 2 and 3 as factors.

The least number, therefore, which is exactly divisible by 12 and 18 must be $2^2 \times 3^2 =$ **36.**

We have then the following rule; resolve the numbers into prime factors, the L.C.M. of the numbers will be the continued product of all the different prime factors which occur in the various numbers, each prime factor being taken to the highest power in which it occurs.

(2) Find the L.C.M. of 16, 24, 35 and 72.

$16 = 2^4$

$24 = 8 \times 3 = 2^3 \times 3$

$35 = 5 \times 7$

$72 = 8 \times 9 = 2^3 \times 3^2$

Now the highest power of 2 which occurs is 2^4, the highest power of 3 which occurs is 3^2, the highest power of 5 which occurs is 5, and the highest power of 7 which occurs is 7.

$\therefore$ The L.C.M. $= 2^4 \times 3^2 \times 5 \times 7 =$ **5040.**

41. When it is desired to find the L.C.M. of two large numbers which cannot be resolved by inspection into prime factors, the best way is to find the H.C.F. of the numbers first. The L.C.M. of the two numbers will clearly be the continued product of the H.C.F., and the factors obtained by dividing each of the numbers by their H.C.F.

To find the L.C.M. of 9504 and 7568.

We first find the H.C.F. of 9504 and 7568 in the usual way:

```
          1
7568 ) 9504      3
       1936 ) 7568      1
              1760 ) 1936     10
                      176 ) 1760
                            ....
```

Thus we see **176** is the H.C.F. of 9504 and 7568.

$9504 = 176 \times 54$

$7568 = 176 \times 43$

$\therefore$ the L.C.M. $= 176 \times 54 \times 43 =$ **408672.**

42. When it is desired to find the L.C.M. of many numbers, it is usual to proceed in the following way.

Write all the numbers in a horizontal row, and strike out any number which is a factor of any other number which occurs (this we may do, since a multiple of a number is a multiple of any factor of that number). Then divide by the smallest **prime number** which is a factor of at least two of the numbers; write down the quotients thus obtained under the numbers divided, and bring down all the remaining numbers. Repeat this process until the numbers remaining have no common factor. The L.C.M. will be the continued product of the divisors and the remaining numbers.

An example will make this clear to the student.

Find the L.C.M. of 2, 6, 9, 25, 30, 42, 72.

```
2 ) 2, 6, 9, 25, 30, 42, 72
    3 ) 25, 15. 21, 36
        25,  5,  7, 12
```

L.C.M. $= 2 \times 3 \times 7 \times 12 \times 25 =$ **12600**

We may cross out 2, 6, 9 since these three are all factors of 72. We divide by 2 which is a factor of 30, 42 and 72; bring down 25 which is not divisible by 2, and place the quotients 15, 21, 36 under the numbers divided. Next we divide by 3 which is a factor of 15, 21, and 36; bring down the 25 as before and place the quotients under the numbers divided. We cross out 5 since 5 is a factor of 25. The remaining numbers, 25, 7 and 12 have no common factor.

The L.C.M. of the numbers in the first row is twice the L.C.M. of the numbers in the second row. And the L.C.M. of the numbers in the second row

is three times the L.C.M. of the numbers remaining in the third row.

Therefore, to obtain the L.C.M. of the original numbers, we find the continued product of the remaining numbers (which have no common factor) and then multiply this result first by 2 and then by 3.

Exercise 10

Find by resolving into factors the L.C.M. of: (1) 6 and 9. (2) 14 and 21. (3) 20 and 25. (4) 7 and 15. (5) 30 and 36. (6) 49 and 63. Find the L.C.M. of: (7) 5, 8, 14, 15, 21, 32. (8) 13, 18, 26, 27, 39. (9) 15, 25, 30, 45, 50. (10) 22, 26, 49, 77, 91. Find the H.C.F. and hence the L.C.M. of the following: (11) 357 and 391. (12) 80784 and 536976. (13) 1929, 7073 and 8359. (14) 2025, 2250 and 3825.

Exercise 11

(1) What number is the same multiple of 13 that 262779 is of 33. (2) A farmer lost one lamb out of every 5 lambs born one season. 281 lambs died. How many were born? (3) What number, when subtracted 13 times from 10000, leaves the remainder 3? (4) What is the least number of times that 591 must be added to 4597, that the sum may exceed 100000? (5) Find the two numbers nearest to 10000 whose H.C.F. is 172. (6) Find the greatest number which will divide 105483 and 79461, and leave remainders 945 and 4791 respectively. (7) A boy has a number of coloured balls, 153 blue ones and 187 red ones. He divides them into the largest possible number of groups, in such a way that each group of blue balls may contain the same number as each group of red balls. How many groups of blue balls has he, and how many of red? (8) Find the least number which when divided by 14, 15, 18 and 20 leaves a remainder 7 in each case. (9) Five church bells toll every 8, 9, 10, 12 and 15 seconds respectively. At what interval do they toll together? (10) One man walks at the rate of 3 miles an hour, a second man bicycles at the rate of 12 miles an hour and a third travels in a motor-car at the rate of 20 miles an hour. What is the least distance they can all travel in an exact number of hours?

43. The student should note that in working out an example such as the following: $207 - 4 \times 3 + 12 \div 6 - 2 \times (4 + 7)$ the operations of multiplication and division must be performed before those of addition and subtraction, unless the figures to be added or subtracted are enclosed in brackets.

Thus, $207 - 4 \times 3 + 12 \div 6 - 2 \times (4 + 7) = 207 - 12 + 2 - 2 \times 11 = 195 + 2 - 22 = 197 - 22 = 175$.

Exercise 12

Work out the following:
(1) $130 - 12 + 2$. (2) $176 + 5 \times 4 - 18 \div 3$. (3) $2002 - 25 \times 4 + 5 \times 20$. (4) $144 \div 12 - 12 \div 2 - 2 \times (1 + 2)$. (5) $18 \times 7 - 5 \times (10 - 3)$. (6) $1741 - 12 \times 13 + 625 \div 25 - 16 \div (3 + 1)$.

44. If a unit be broken up into a number of equal parts, one or more of these parts is called a **Fraction** of the unit.

Supposing a unit divided into 2 equal parts, then each part is called $\frac{1}{2}$ (one-half); if it is divided into 3 equal parts, each part is called $\frac{1}{3}$ (one-third); if it is divided into 4 equal parts, each part is called $\frac{1}{4}$ (one-quarter or one fourth); if it is divided into 5, 6, 7, 8, etc., equal parts, then each part is called $\frac{1}{5}$ (one-fifth), $\frac{1}{6}$ (one-sixth), $\frac{1}{7}$ (one-seventh), $\frac{1}{8}$ (one-eighth), etc.

Supposing a unit is broken into 5 equal parts, then 3 of those parts taken together are called $\frac{3}{5}$ (three-fifths).

45. A Vulgar Fraction consists of two numbers one above the other and divided by a horizontal line. The lower number called the **Denominator** shows how many equal parts the unit has been broken into, and the upper number, called the **Numerator,** shows how many of these equal parts have been taken. Thus, $\frac{5}{8}$ (five-eighths) denotes that a unit has been divided into 8 equal parts and that 5 of them have been taken.

It will probably assist the student if we take a concrete example:

Suppose we take as a unit one shilling. We can break this up into 12 equal parts. Then each part is $\frac{1}{12}$ (one-twelfth) of a shilling. When a shilling is divided into 12 equal parts, we call each of these parts one penny. Thus we see that one penny is $\frac{1}{12}$ of one shilling. If we take 5 pennies then we have $\frac{5}{12}$ (five-twelfths) of a shilling.

46. Now supposing we have 3 units and divide each of them into 12 equal parts, and then take one of these equal parts from each of the 3 units, we shall take one part out of every 12 from each of the 3 units; that is to say we shall take one-twelfth of the whole three units. But each of these parts is one-twelfth of a single unit, and as we take 3 of them, we shall have taken three-twelfths of a single unit.

Thus, $\frac{3}{12}$ (three-twelfths) of 1 unit is the same as $\frac{1}{12}$ (one-twelfth) of 3 units.

Hence, $\frac{3}{12}$ which we have defined as three-twelfths of 1 unit, may also be considered as one-twelfth of 3 units.

To make this clear, let us return to our previous illustration.

Suppose each of the 3 units is a shilling, then if each of the shillings is broken up into 12 equal parts (i.e. pennies) we shall have altogether $3 \times 12 = 36$ equal parts (pennies).

If we take $\frac{1}{12}$ of each of the 3 shillings (i.e. one penny from each of the 3 shillings), we shall have taken altogether $\frac{1}{12}$ of the 3 shillings (i.e. we shall have taken 3 pennies). But each of these is $\frac{1}{12}$ of 1 shilling (i.e. a penny), and if we take 3 of them then we shall have $\frac{3}{12}$ of one shilling (i.e. 3 pennies).

Thus, $\frac{1}{12}$ of 3 shillings is the same as $\frac{3}{12}$ of 1 shilling.

The student should verify this by actually performing the operation. If he has not got 36 pennies handy, a box of matches will form a good substitute. Take 36 matches, pretend they are pennies, and arrange them in 3 groups of 12 each. Then each group of 12 will represent one shilling divided into 12 equal parts, and each match will represent one of the 12 equal parts (i.e. one penny).

47. A Fraction also represents the quotient of the numerator by the denominator.

Thus, $\frac{5}{8}$ represents $5 \div 8$, since we have just

shown that it comes to the same thing whether we divide 1 unit into 8 equal parts and then take 5 of them, or divide 5 units into 8 equal parts and take one of them. The latter is equivalent to $\frac{1}{8}$ of 5 units, i.e. $5 \div 8$; hence $\frac{5}{8}$ denotes the same thing as $5 \div 8$.

Exercise 13

(1) Write in figures the following fractions; two-thirds, one-ninth, six forty-thirds, ninety-seven hundredths, four hundred and thirty-three one thousand and fourths, six hundred and forty-seven twenty-oneths.

(2) Write in words the following fractions:

$\frac{2}{5}$, $\frac{4}{19}$, $\frac{22}{37}$, $\frac{141}{372}$, $\frac{397}{401}$, $\frac{1008}{392}$, $\frac{451}{10001}$.

(3) How much is:

(*a*) $\frac{3}{5}$ of £1. (*b*) $\frac{3}{4}$ of 1*s*. (*c*) $\frac{1}{2}$ of 6*d*. (*d*) $\frac{1}{3}$ of 1 yd. (*e*) $\frac{3}{8}$ of 1 day. (*f*) $\frac{4}{5}$ of £5. (*g*) $\frac{4}{5}$ of £3. (*h*) $\frac{7}{8}$ of 2 yds. (*k*) $\frac{4}{15}$ of 1 hour. (*l*) $\frac{2}{7}$ of 14*s*. (*m*) $\frac{7}{20}$ of 1 minute. (*n*) $\frac{2}{15}$ of half-a-crown.

48. The numerator and denominator of a fraction are called its **terms.**

A **Proper Fraction** is one in which the numerator is less than the denominator.

Thus, $\frac{2}{3}$, $\frac{5}{16}$ are proper fractions.

An **Improper Fraction** is one in which the numerator is greater than the denominator.

Thus $\frac{5}{2}$, $\frac{24}{11}$ are improper fractions.

A **Mixed Number** is a number which consists of a fraction and a whole number (usually called an **Integer**).

Thus, $2\frac{5}{8}$, $100\frac{1}{2}$ are mixed numbers.

49. Any integer can be expressed as a fraction with the denominator 1.

Consider the integer 6. If we write it $\frac{6}{1}$ this means $6 \div 1 = 6$.

50. To express a mixed number as an **improper fraction** consider $7\frac{2}{9}$. This means 7 whole units and 2 ninths of a unit.

Now in 1 unit there are 9 ninths.

$\therefore$ in 7 units „ „ 7×9 ninths $= 63$ ninths.

$\therefore$ $7\frac{2}{9} = 63$ ninths and 2 ninths $= 65$ ninths $= \frac{65}{9}$.

Or we may write it this way:

$$7\frac{2}{9} = \frac{63}{9} + \frac{2}{9} = \frac{63+2}{9} = \frac{65}{9}.$$

Hence we see that to express a mixed number as an improper fraction, we multiply the integer by the denominator of the fraction and add the numerator. This gives us the numerator of the improper fraction, and the denominator is the same as that of the original fraction.

51. To express an improper fraction as a mixed number.

Consider $\frac{65}{9}$. Since 9 ninths make 1 unit, 63 ninths make 7 units.

$$\frac{65}{9} = \frac{63+2}{9} = \frac{63}{9} + \frac{2}{9} = 7 + \frac{2}{9} = 7\frac{2}{9}.$$

Hence we see that to express an improper fraction as a mixed number we divide the numerator by the denominator, put down the quotient as a whole number and the remainder as the numerator of a proper fraction, the denominator being the same as that of the original fraction.

52. It is obvious that any integer may be expressed as an improper fraction having any denominator we please.

Consider the integer 5. Suppose we wish to express it as a fraction with the denominator 8.

Since in 1 unit there are 8 eighths, in 5 units there are 5×8 eighths $= 40$ eighths $= \frac{40}{8}$.

We may write this thus, $5 = \frac{5 \times 8}{8} = \frac{40}{8}$.

Hence, if we have an improper fraction of which the numerator is a multiple of the denominator, we may write it as an integer.

Consider $\frac{28}{7}$.

$$\frac{28}{7} = \frac{4 \times 7}{7} = 4 \text{ times } 7 \text{ sevenths.}$$

But 7 sevenths $= 1$, $\therefore$ 4 times 7 sevenths $= 4 \times 1 = 4$.

Exercise 14

Express as improper fractions the following mixed numbers:

(1) $8\frac{3}{11}$. (2) $25\frac{4}{15}$. (3) $37\frac{1}{8}$. (4) $17\frac{8}{100}$. (5) $40\frac{5}{91}$. (6) $2\frac{999}{1000}$. (7) $4\frac{853}{4750}$. (8) $104\frac{6}{25}$.

Express as mixed numbers the following improper fractions:

(9) $\frac{13}{5}$. (10) $\frac{24}{11}$. (11) $\frac{37}{8}$. (12) $\frac{1026}{43}$. (13) $\frac{91}{13}$. (14) $\frac{2002}{101}$. (15) $\frac{5843}{900}$. (16) $\frac{6257}{8005}$. (17) $\frac{100001}{1001}$. (18) $\frac{3125}{25}$. (19) Express 3, 5, 7, 9 as fractions with the denominator 8. (20) Express 2, 4, 6, 8 as fractions with the denominator 15.

53. To multiply a fraction by an integer, we multiply the numerator by the integer.

Consider $\frac{2}{5} \times 4$.

Just as 2 hours $\times 4 = 8$ hours.

so 2 fifths $\times 4 = 8$ fifths.

i.e. $\frac{2}{5} \times 4 = \frac{8}{5}$.

In other words, 4 times as many parts are taken in $\frac{8}{5}$ as are taken in $\frac{2}{5}$.

54. To divide a fraction by an integer we divide the numerator by the integer.

Consider $\frac{6}{7} \div 3$.

Just as 6 hours $\div 3 = 2$ hours.

so 6 sevenths $\div 3 = 2$ sevenths.

i.e. $\frac{6}{7} \div 3 = \frac{2}{7}$.

Supposing, however, the numerator is not a multiple of the integer, and therefore cannot be divided by it an exact number of times, then we multiply the denominator by the integer.

Consider $\frac{5}{11} \div 3$.

In the fraction $\frac{5}{11}$, a unit is divided into 11 equal parts and 5 of them are taken. Now suppose each of the 11 equal parts again divided into 3 equal parts. There will be $3 \times 11 = 33$ such equal parts, and

each of them will be one third of the original parts, and ∴ 5 of these will be one third of 5 of the original parts, i.e. each of the parts in $\frac{5}{11 \times 3}$ is one third of each of the parts in $\frac{5}{11}$, and thus $\frac{5}{11} \div 3 = \frac{5}{11 \times 3} = \frac{\mathbf{5}}{\mathbf{33}}$.

55. If the numerator and denominator of a fraction be multiplied or divided by the same number, the value of the fraction is not altered.

Consider the fraction $\frac{5}{6}$, and multiply both numerator and denominator by 4.

$$\frac{5 \times 4}{6 \times 4} = \frac{\mathbf{20}}{\mathbf{24}}.$$

In the original fraction $\frac{5}{6}$, the unit is broken up into 6 equal parts, and 5 of them are taken. Now suppose each of the 6 equal parts subdivided into 4 equal parts, then we shall have $6 \times 4 = 24$ equal parts, and the 5 of the original parts which were taken will each be made up of 4 of the 24 equal parts, i.e. there will be $5 \times 4 = 20$ of these parts.

Thus we see $\frac{5}{6} = \frac{20}{24}$.

To make this quite clear to the student we may take an illustration similar to the one we used before.

Suppose our unit is a sixpenny piece. If we divide that into 6 equal parts we shall have 6 pennies, and if we take 5 of these we shall have 5 pennies. Now suppose each of the original 6 pennies were broken up into 4 equal parts, i.e. into farthings, then the unit 6d. is seen to be made up of 24 farthings, and $\frac{5}{6}$ of the unit, i.e. 5d., is seen to be made up of 20 farthings.

That is $\frac{5}{6} = \frac{20}{24}$.

It is clear that if we reverse the process and divide both the numerator and denominator by the same number, the value of the fraction again remains unaltered.

Consider the fraction $\frac{20}{24}$. Divide both numerator and denominator by 4.

$\frac{20 \div 4}{24 \div 4} = \frac{5}{6}$. And we have shown above that $\frac{5}{6} = \frac{\mathbf{20}}{\mathbf{24}}$.

56. To multiply the numerator of a fraction by any number is the same as to divide the denominator by that number, and conversely.

Consider the fraction $\frac{5}{8}$: divide its denominator by 4, the result is $\frac{5}{2}$. The unit is now divided into 2 equal parts instead of into 8, and each part is 4 times as large as before. The same number of parts as before, namely 5, is taken, and ∴ the fraction is 4 times as large as before. But to make a fraction 4 times as large as before we may multiply the numerator by 4,

$$\therefore \frac{5 \times 4}{8} = \frac{\mathbf{5}}{\mathbf{8 \div 4}}$$

Alternative proof. Consider the fraction $\frac{5}{8}$ and multiply the numerator by 4; we then get $\frac{5 \times 4}{8}$.

Now, by § 55 we shall not alter the value of the fraction if we divide both numerator and denominator by 4,

$\therefore \frac{5 \times 4}{8} = \frac{5 \times 4 \div 4}{8 \div 4} = \frac{5}{8 \div 4}$ (since first multiplying and then dividing the numerator by 4 are two operations which cancel one another and leave the numerator unchanged).

Similarly, if you divide the numerator of $\frac{8}{11}$ by 4 the result is $\frac{2}{11}$. The unit is divided as originally into 11 equal parts, but only one fourth of the former 8 parts are taken. Therefore the fraction is divided by 4, and as we know, to divide a fraction by 4 we may multiply its denominator by 4, i.e. $\frac{8 \div 4}{11} = \frac{\mathbf{8}}{\mathbf{11 \times 4}}$.

Thus we see that in order to multiply a fraction by a number we may divide its denominator by that number; and in order to divide a fraction by a number, we may divide its numerator by that number. Whenever exact division is possible it is to be preferred to multiplication.

57. A fraction is said to be in its **lowest terms** when the numerator and denominator have no common factor.

Thus, $\frac{2}{13}, \frac{5}{27}, \frac{91}{92}$ are in their lowest terms. But $\frac{6}{8}, \frac{18}{20}, \frac{92}{94}$ are not in their lowest terms, for in each case the numerator and denominator have a common factor 2.

58. To reduce a fraction to its lowest terms:

Examples:

(1) Reduce $\frac{15}{20}$ to its lowest terms. The numerator and denominator have a common factor 5. Now we have just shown (§ 55) that the value of a fraction is not affected by dividing both numerator and denominator by the same number. Hence we divide the numerator 15 and the denominator 20 by 5. The result is $\frac{3}{4}$.

(2) Reduce $\frac{1820}{2093}$ to its lowest terms. To do this we must find the H.C.F. of the numerator and denominator, and divide each of them by it. We shall thus get a fraction whose numerator and denominator are prime to one another, i.e. have no common factor. The H.C.F. of 1820 and 2093 will be found to be 91.

$$\frac{1820}{2093} = \frac{1820 \div 91}{2093 \div 91} = \frac{\mathbf{20}}{\mathbf{23}}.$$

(3) It is often easier to reduce the fraction by successive divisions by factors that can be seen by inspection.

Reduce $\frac{1001}{1155}$ to its lowest terms.

$$\frac{1001}{1155} = \frac{91}{105} \text{ dividing by 11}$$
$$= \frac{\mathbf{13}}{\mathbf{15}} \text{ dividing by 7.}$$

(4) It is usual to write the reduction as follows:

Reduce $\frac{7845}{96780}$ to its lowest terms.

$$\frac{7845}{96780} = \frac{1569}{19356} = \frac{\mathbf{523}}{\mathbf{6452}}$$

(dividing first by 5 and then by 3).

(5) Or again the reduction may be written as follows:

Reduce $\frac{735}{1323}$ to its lowest terms.

$$\begin{matrix}5\\ \cancel{15}\\ \cancel{105}\\ \cancel{735}\\ \cancel{1323}\\ \cancel{189}\\ \cancel{27}\\ 9\end{matrix} = \frac{\mathbf{5}}{\mathbf{9}}$$

In this case we divide twice by 7 and then by 3. We cross out each number as we divide it and write the quotient above the number in the numerator and below the number in the denominator.

This form of reduction is most useful when it occurs as part of some larger calculation, as it takes up little room, but the student should take care to do it neatly, otherwise errors may easily creep in.

Exercise 15

(1) Multiply $\frac{5}{18}$ separately by 3, 4, 9, 12 and 36.
(2) Multiply $\frac{37}{40}$ separately by 7, 16, 35, 40 and 42.
(3) Divide $\frac{6}{11}$ separately by 2, 3, 4, 7 and 12.
(4) Divide $\frac{30}{83}$ separately by 2, 3, 4, 5, 25, 35, 36 and 60.

Reduce the following fractions to their lowest terms:

(5) $\frac{2}{4}, \frac{4}{8}, \frac{8}{10}, \frac{9}{12}, \frac{15}{18}, \frac{27}{81}, \frac{50}{105}, \frac{77}{132}$. (6) $\frac{144}{264}$. (7) $\frac{101}{253}$. (8) $\frac{840}{848}$. (9) $\frac{1995}{2553}$. (10) $\frac{5953}{107884}$. (11) $\frac{175428}{701808}$. (12) $\frac{111185}{220681}$.

Key to Exercise 7

(1) 12. (2) 22 remainder 11. (3) 843 rem. 114. (4) 3681 rem. 171. (5) 165 rem. 997. (6) 431 rem. 31413. (7) 329 rem. 38. (8) 4973 rem. 14. (9) 7132 rem. 55. (10) 45070 rem. 121. (11) 8301 rem. 62. (12) 16675 rem. 1072. (13) 7132 rem. 46457. (14) 454 rem. 1808228. (15) 90909 times, rem. 1.

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37 (*continued*).—The following are further examples of products which can be written down immediately:

$$(a^2 + \sqrt{2}b^2)(a^2 - \sqrt{2}b^2) = (a^2)^2 - (\sqrt{2})^2 (b^2)^2 = a^4 - 2b^4$$

$$(a - b + c)(a + b - c) = \{a - (b - c)\} \times \{a + (b - c)\} = a^2 - (b - c)^2$$

$$(x^2 + xy + y^2)(x^2 - xy + y^2) = \{(x^2 + y^2) + xy\} \times \{(x^2 + y^2) - xy\} = (x^2 + y^2)^2 - (xy)^2 = x^4 + x^2y^2 + y^4$$

$$(x^3 + x^2 + x + 1)(x^3 - x^2 + x - 1) = \{(x^3 + x) + (x^2 + 1)\}\{(x^3 + x) - (x^2 + 1)\} = (x^3 + x)^2 - (x^2 + 1)^2 = x^6 + 2x^4 + x^2 - (x^4 + 2x^2 + 1) = x^6 + x^4 - x^2 - 1$$

Exercise 5

Find the following products—

(1) $(3x + 2)(4x - 5)$.
(2) $(5a - 4b)(-3a + 2b)$.
(3) $(a^2 + a + 1)(a - 1)$.
(4) $(a^2 + ab + b^2)(a - b)$.
(5) $(x^2 - 2x + 4)(2 - x)$.
(6) $(1 - ab + a^2b^2)(1 + ab - a^2b^2)$.
(7) $(5x^2 + 4xy - 3y^2)(2x^2 - 3xy - 4y^2)$.
(8) $(a^2 - 5ab + 6b^2)(3a^2 + 2ab - 2b^2)$.
(9) $(a^3x^3 - 2a^2x^2y^2 + 3y^6)(2a^3x^3 + axy^4 - 4y^6)$.
(10) $(x^2 + y^2 + z^2 - xy - yz - zx)(x + y + z)$

Simplify the following:—

(11) $(a + b + c)^2 - (-a + b + c)^2 + (a - b + c)^2 - (a + b - c)^2$.
(12) $(a + b)(a^2 - ab + b^2)$.
(13) $(a^3 - a^2 + a - 1)(a^3 + a^2 - a - 1)$.
(14) Show that

$$(a+b)^2 + (b+c)^2 + (c+a)^2 - a^2 - b^2 - c^2 = (a+b+c)^2.$$

38. The student will have noticed that when an algebraic expression contains different powers of the same letter, we have usually arranged the terms either in descending or in ascending powers of the letter. This arrangement is not necessary, but it is usually done as it is convenient and clear.

A term which is the product of n letters is said to be of n dimensions, or of the nth **degree.** Thus, $9abcd$ is of the 4th degree, and $2a^3b^2$, which equals $2aaabb$, is of the 5th degree.

The **degree of an algebraic expression** is determined by the dimensions of its highest term. Thus, $3x^2 + 4x^2y + y + 1$ is of the 3rd degree, since its highest term, $4x^2y$, is of the 3rd degree.

When all the terms of an algebraic expression are of the same degree it is said to be **homogeneous.** Thus, $3a^2b + 4ac^2 + b^2c + c^3$ is homogeneous, since each term is of the 3rd degree.

Sometimes we estimate the degree of an expression with regard to a certain letter or certain letters only. Thus, $3ax^2 + 2bx + c$ is said to be of the 2nd degree **in x,** and is called a **quadratic expression in x;** similarly, $ax^3 + bx^2y + cxy^2 + dy^3$ is an expression of the 3rd degree **in x and y.** Further, it is a homogeneous expression in x and y. The term dy^3 is said to be of **no degree in x,** or to be **independent of x.**

39. The product of two homogeneous expressions must clearly be homogeneous. For if the multiplier be homogeneous of the mth degree, and the multiplicand be homogeneous of the nth degree, since each term of the product is obtained by multiplying a term of the mth degree by a term of the nth degree, it follows that each term of the product is of the $(m + n)$th degree; i.e. the product is homogeneous.

40. Detached coefficients.—When two expressions, which are to be multiplied together, are arranged either in descending or in ascending order of some letter, we may find their product by writing down their coefficients only.

Thus, to multiply $4x^2 + x - 2$ by $3x^2 - 2x + 1$.

$$\begin{array}{r} 4 + 1 - 2 \\ 3 - 2 + 1 \\ \hline 12 + 3 - 6 \\ \quad -8 - 2 + 4 \\ \quad\quad +4 + 1 - 2 \\ \hline 12 - 5 - 4 + 5 - 2 \end{array}$$

The highest power of x in the product is x^4, and the rest follow in order. Hence the product is

$$12x^4 - 5x^3 - 4x^2 + 5x - 2.$$

If any powers of the letter are absent we must supply 0 in the place of their coefficients.

Thus, to multiply $x^3 - 2x + 1$ by $x^3 + x^2 - 1$.

$$\begin{array}{r} 1 + 0 - 2 + 1 \\ 1 + 1 + 0 - 1 \\ \hline 1 + 0 - 2 + 1 \\ \quad 1 + 0 - 2 + 1 \\ \quad\quad - 1 + 0 + 2 - 1 \\ \hline 1 + 1 - 2 - 2 + 1 + 2 - 1 \end{array}$$

Hence the product is $x^6 + x^5 - 2x^4 - 2x^3 + x^2 + 2x - 1$.

41. The square of a multinomial expression.—We have already found the square of the sum of two and of three algebraic quantities. We will now see how to find the square of a multinomial expression.

To find $(a + b + c + d + \ldots.)^2$

$(a + b + c + d + \ldots.)^2$

$= (a + b + c + d + \ldots.)\ (a + b + c + d + \ldots.)$

The product will be the sum of all the partial products obtained by multiplying each term of the multiplicand by each term of the multiplier. Now, if we multiply the term a of the multiplicand by the term a of the multiplier, that will give us the term $+ a^2$. No other two terms of the multiplier and multiplicand when multiplied together will give us a term in a^2; hence one term in our product is $+ a^2$. Similarly we obtain the terms $+ b^2$, $+ c^2$, $+ d^2$, and so on. Now, we can multiply any term of the multiplicand, say b, by any term of the multiplier, say c. This will give a term $+ bc$; but if we multiply the term c of the multiplicand by the term b of the multiplier, this will also give a term $+ bc$. No other two terms of the multiplier and multiplicand multiplied together will give a term in bc, hence we obtain a term of our product $(+ bc + bc) = + 2bc$. Every term in which two letters are involved is thus seen to occur *twice* in the product. Hence the product consists of the sum of the squares of all the different quantities a, b, c, etc., together with twice the product of every pair. We may state it thus:

The square of the sum of any number of algebraic quantities is equal to the sum of their squares together with twice the product of every pair.

Examples:

(1) $(2a + 3b + c)^2$

$= (2a)^2 + (3b)^2 + c^2 + 2(2a)(3b) + 2(2a)c + 2(3b)c$

$= 4a^2 + 9b^2 + c^2 + 12ab + 4ac + 6bc.$

(2) $(a + b - c - d)^2$.

$= (a)^2 + (b)^2 + (-c)^2 + (-d)^2 + 2(a)(b) + 2(a)(-c) + 2(a)(-d) + 2(b)(-c) + 2(b)(-d) + 2(-c)(-d)$

$= a^2 + b^2 + c^2 + d^2 + 2ab - 2ac - 2ad - 2bc - 2bd + 2cd.$

The student should very soon be able to write down these results without the ntermediate stages.

42. Continued Products.—The continued product of three or more factors is found by multiplying the product of the first two factors by the third, then multiplying this product by the fourth factor, and so on.

(1) Thus, to find $(x + a)(x + b)(x - c)$.

$$\begin{array}{l} x + a \\ x + b \\ \hline x^2 + ax \\ \quad + bx + ab \\ \hline x^2 + (a + b)x + ab \\ x - c \\ \hline x^3 + (a + b)x^2 + abx \\ \quad\quad + cx^2 - c(a + b)x - abc \\ \hline x^3 + (a + b - c)x^2 + (ab - bc - ca)x - abc. \end{array}$$

The student will notice that all terms containing the same power of x are bracketed together. It is usually convenient to arrange them in this way.

(2) To find $(x + y)^2(x - y)^2(x^2 + y^2)^2$.

We may arrange the factors in any order.

$(x + y)^2(x - y)^2(x^2 + y^2)^2$

$= [(x + y)(x - y)(x^2 + y^2)]^2$

$= [(x^2 - y^2)(x^2 + y^2)]^2 = (x^4 - y^4)^2$

$= x^8 - 2x^4y^4 + y^8.$

43. To find $(a + b)^3$.

$(a + b)^3 = (a + b)(a + b)(a + b)$.

If we multiply all the terms of each of the three factors together in every possible way, we shall obtain the continued product.

We can take a from each factor, i.e. 3 times, and this can be done in only one way, $\therefore$ a^3 is a term of the continued product.

We can take a twice and b once, and these can be done in 3 ways, $\therefore$ b can be taken from any one of the three factors, $\therefore$ $3a^2b$ is a term of the continued product.

We can take a once and b twice, and this can also be done in 3 ways, $\therefore$ $3ab^2$ is a term of the continued product.

Finally, we can take b 3 times, and this can be done in only one way $\therefore$ b^3 is a term of the continued product.

Hence $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$.

Similarly, to find $(x + a)(x + b)(x + c)$.

We can take x 3 times in one way only; this gives us x^3.

We can take x^2 with either a, b or c; this gives us ax^2, bx^2, cx^2.

We can take x once with any two of a, b, c; this gives us abx, bcx, cax.

Finally, we can take no x, but simply a, b and c together; this gives us abc.

Hence, arranging the terms containing the same power of x together,

$$(x + a)(x + b)(x + c) = x^3 + (a + b + c)x^2 + (ab + bc + ca)x + abc.$$

The student can easily work this out by ordinary multiplication, but he should practise multiplying in the above manner without the intermediate steps.

The student is advised to prove and learn by heart the following results, the first of which has been proved:

$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$

$(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$

$(a + b + c)^3 = a^3 + b^3 + c^3 + 3a^2b + 3a^2c + 3ab^2 + 3ac^2 + 3b^2c + 3bc^2 + 6abc$

$(a - b + c)^3 = a^3 - b^3 + c^3 - 3a^2b + 3a^2c + 3ab^2 + 3ac^2 + 3b^2c - 3bc^2 - 6abc.$

Exercise 6

Find the following:

(1) $(x^6+1)(x^3+1)(x^3-1)$.

(2) $(a^2+b^2)^3(a+b)^3(a-b)^3$.

(3) $(a^3-a+1)(a^3+a-1)(a^4-a^2+1)$.

(4) $(x^2+2y+1)(x^2-2y-1)(x^4+4y^2+1)$.

(5) $(a^3+2ab+4b^2)(a^3-2ab+4b^2)(a^4-4a^2b^2+16b^4)$.

(6) Find the squares of $(x-y-z)$, $(a+2b-3c)$, $(2a-3b+4c)$, (a^3+a^2-a-1), (x^3+x^2+x-1).

(7) Find the cubes of $(2a+3b)$, $(4a-5b)$, $(a+2b-3c)$, $(2a-3b+4c)$, $(1-a-a^2)$.

(8) Show that $(a-b)^3+(b-c)^3+(c-a)^3 = 3(a-b)(b-c)(c-a)$.

(9) Show that if $x=a^2-bc$, $y=b^2-ca$, $z=c^2-ab$,
then $ax+by+cz=(x+y+z)(a+b+c)$.
and $bc(x^2-yz)=ca(y^2-zx)=ab(z^2-xy)$.

(10) Show that $x(x-y+z)(x+y-z)+y(x+y-z)(-x+y+z)+z(x-y+z)(-x+y+z)+(-x+y+z)(x-y+z)(x+y-z)=4xyz$.

44. Division.—We have already dealt with the division of one monomial by another. We will now deal with the division of multinomials by monomials and by multinomials.

By the law of distribution, § 29,

(1) $(a^2b+ab^2+abc)\div ab$
$= a^2b\div ab + ab^2\div ab + abc\div ab$
$= a+b+c$.

(2) $(6x^2-8ax+4bx)\div 2x$
$= 6x^2\div 2x - 8ax\div 2x + 4bx\div 2x$
$= 3x-4a+2b$.

When the divisor is not a monomial we proceed as follows:

Since division is the inverse of multiplication, what we have to do is to find an algebraic expression which when multiplied by the divisor will produce the dividend.

We arrange both divisor and dividend in descending powers of some common letter. The first term of the quotient will be some algebraic quantity which when multiplied by the first term of the divisor will give the first term of the dividend. We find this algebraic quantity by dividing the first term of the dividend by the first term of the divisor, and we set this down as the first term of the quotient. Then we multiply the whole divisor by the first term of the quotient, and subtract this product from the dividend. The process is then repeated, only that the remainder obtained by subtracting takes the place of the original dividend, and so on.

(3) $(6x^3-10x^2y+11xy^2+5y^3)\div(3x+y)$.

$3x+y)\,6x^3-10x^2y+11xy^2+5y^3\,(2x^2-4xy+5y^2$
$6x^3+2x^2y$
$-12x^2y+11xy^2+5y^3$
$-12x^2y-4xy^2$
$+15xy^2+5y^3$
$+15xy^2+5y^3$

The first term of the quotient is $6x^3\div 3x = 2x^2$. Multiplying the whole divisor by $2x^2$ and subtracting the product from the dividend, we have the remainder $-12x^2y+11xy^2+5y^3$. The second term of the quotient is $-12x^2y\div 3x = -4xy$. Multiplying the divisor by $-4xy$ and subtracting the product from the first remainder, we get the second remainder $+15xy^2+5y^3$. The third term of the quotient is $+15xy^2\div 3x = +5y^2$. Multiplying the divisor by $+5y^2$ and subtracting the product from $15xy^2+5y^3$, we get no remainder.

As there is no remainder, the dividend must equal the sum of the expressions subtracted from it, and these expressions are the divisor multiplied first by $2x^2$, then by $-4xy$, and then by $+5y^2$.

∴ The dividend $6x^3-10x^2y+11xy^2+5y^3$
= the divisor $(3x+y)\times(2x^2-4xy+5y^2)$
i.e. $2x^2-4xy+5y^2$ is the required quotient.

The divisor and dividend may be arranged in ascending powers of some letter (the above is arranged in ascending powers of y though in descending powers of x), but they must both be arranged in the same way.

We will give a few more examples.

(4) $(a^3+b^3+c^3-3abc)\div(a+b+c)$.

$a+b+c)\,a^3-3abc+b^3+c^3\,(a^2-ab-ac+b^2-bc+c^2$
$a^3+a^2b+a^2c$
$-a^2b-a^2c-3abc+b^3+c^3$
$-a^2b-ab^2-abc$
$-a^2c+ab^2-2abc+b^3+c^3$
$-a^2c\quad -abc-ac^2$
$+ab^2-abc+ac^2+b^3+c^3$
$+ab^2\quad +b^3+b^2c$
$-abc+ac^2-b^2c+c^3$
$-abc\quad -b^2c-bc^2$
$+ac^2+bc^2+c^3$
$+ac^2+bc^2+c^3$

The above may be shortened by the use of brackets.

$a+b+c)\,a^3-3abc+b^3+c^3\,(a^2-a(b+c)+(b^2-bc+c^2$
$a^3+a^2(b+c)$
$-a^2(b+c)-3abc+b^3+c^3$
$-a^2(b+c)-a(b+c)^2$
$+a(b^2-bc+c^2)+b^3+c^3$
$+a(b^2-bc+c^2)+b^3+c^3$

(5) The method of detached coefficients may also be used in division.

$(12x^3-11x^2+21x+27)\div(3x^2-5x+9)$.

$3-5+9)\,12-11+21+27\,(4+3$
$12-20+36$
$+9-15+27$
$+9-15+27$

The quotient is $4x+3$, since $x^3\div x^2 = x$.

45. Cases arise in which the dividend is not exactly divisible by the divisor. If we have arranged the divisor and dividend in descending powers of x, it is clear that the remainder after the first subtraction must be of a lower degree in x than the dividend, and the second remainder must be of a lower degree in x than the first remainder. We can proceed until either there is no remainder (as in the examples worked above) or the highest power of x in the remainder is lower than the highest power of x in the divisor. In this latter case the dividend is not exactly divisible by the divisor.

We must therefore extend our definition of division to include such cases.

To divide an algebraic expression A *by an algebraic expression* B *is to find an algebraic expression* C *such that either* B × C *equals* A, *or* B × C *differs from A by an algebraic expression* R, *which is of a lower degree in some particular letter than* B.

Thus we have B × C = A, or B × C + R = A.

Examples:

(1) $(x^2 - 3xy + 5y^2) \div (x + y)$.

$$\begin{array}{r|l} x+y & x^2-3xy+5y^2 \;(\; x-4y \\ & \underline{x^2+xy} \\ & \quad -4xy+5y^2 \\ & \quad \underline{-4xy-4y^2} \\ & \qquad +9y^2 \end{array}$$

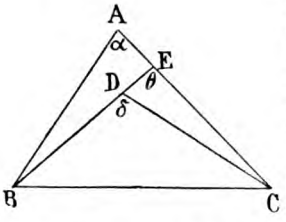
Hence $x^2 - 3xy + 5y^2 = (x+y)(x-4y) + 9y^2$.

M. A. L.

GEOMETRY.—IV

Proposition 13. Theorem

If, from the ends of one side of a triangle, two straight lines be drawn to meet at a point within the triangle, these two straight lines are together less than the other two sides of the triangle, but the angle they contain is greater than the angle contained by those two sides of the triangle.



Let A B C be a △ having the str. lines B D, C D drawn from the ends B and C of the side B C, to meet at the pt. D within the △.

It is required to prove that B D + D C < B A + A C and that δ > α.

Proof.—Produce B D to cut A C at E.

(1) In △ A B E, B A + A E > B E (Prop. 12).

To each add E C,

then B A + A E + E C > B E + E C,

i.e. B A + A C > B D + D E + E C.

Again in △ E D C, D E + E C > D C (Prop. 12).

To each add B D,

then B D + D E + E C > B D + D C

∴ all the more B A + A C > B D + D C,

i.e. B D + D C < B A + A C.

(2) θ is the ext. ∠ of △ B A E

∴ θ > α (Prop. 4, Cor. 4).

Also δ is the ext. ∠ of △ E D C

∴ δ > θ (Prop. 4, Cor. 4)

∴ All the more δ > α.

Proposition 14. Theorem

If two triangles have two sides of the one equal to two sides of the other respectively, and if the angles opposite to one pair of equal sides are equal, then the angles opposite to the other pair of equal sides are (*a*) *equal or* (*b*) *supplementary.*

Let A B C, D E F be the △s having A B = D E

A C = D F

β = θ

It is required to prove that (*a*) γ = φ or (*b*) γ + φ = 2 rt. ∠s.

Proof.—One of the following three statements must be true: (1) B C = E F, (2) B C < E F, (3) B C > E F.

(1) Suppose B C = E F (Fig. 1).

In △s A B C, D E F, A B = D E

B C = E F

included ∠ β = included ∠ θ.

∴ △ A B C ≡ △ D E F (Prop. 5)

and ∴ γ = φ.

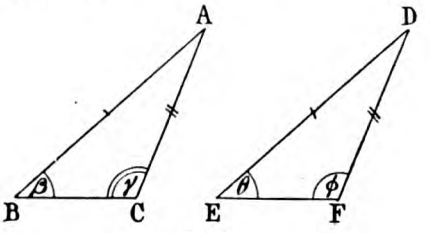


Fig. 1.

(2) Suppose B C < E F (Fig. 2).

Place △ A B C on △ D E F so that A B lies along D E; then if A be placed on D, B will fall on E ∵ A B = D E.

Now β = θ ∴ B C will lie along E F.

Also B C < E F ∴ C will lie at the point C′ between E and F.

Now D F = D C′ (for D C′ is A C, and A C = D F), i.e. △ D C′ F is isosceles

∴ μ = φ (Prop. 6).

But λ + μ = 2 rt. ∠s (Prop. 1)

∴ λ + φ = 2 rt. ∠s,

i.e. γ + φ = 2 rt. ∠s.

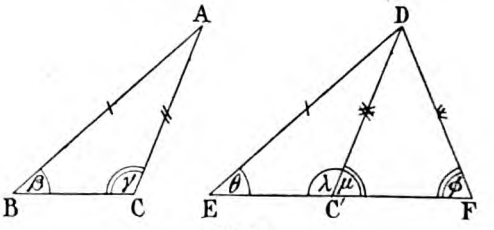


Fig. 2.

(3) Suppose B C > E F (Fig. 3).

Place △ A B C on △ D E F as before.

Now B C > E F ∴ C will lie at the point C′ in E F produced.

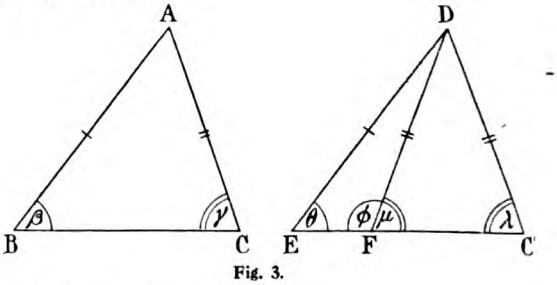


Fig. 3.

△ D F C′ is isosceles

∴ μ = λ (Prop. 6).

But φ + μ = 2 rt. ∠s (Prop. 1)

∴ φ + λ = 2 rt. ∠s,

i.e. φ + γ = 2 rt. ∠s.

Proposition 15. Theorem

If two triangles have two sides of the one equal to two sides of the other respectively, and if the included angles be not equal, then the base of the triangle which has the greater included angle shall be greater than the base of the other.

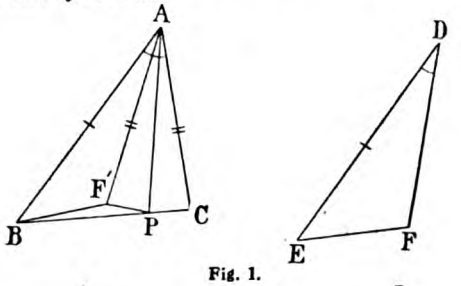


Fig. 1.

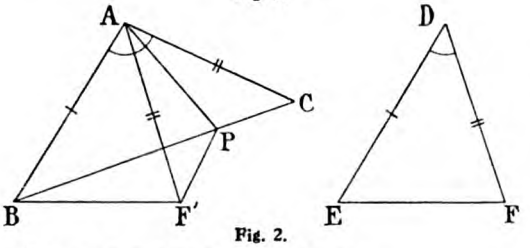


Fig. 2.

Let A B C, D E F be the △s having

A B = D E
A C = D F
∠ B A C > ∠ E D F.

It is required to prove that B C > E F.

Proof.—Place △ D E F on △ A B C so that D falls on A and D E on A B, then since D E = A B the point E will fall on the point B.

Now ∠ B A C > ∠ E D F ∴ D F must lie in some position A F′ between A B and A C.

F′ may lie within the △ A B C as in Fig. 1, or without the △ A B C, as in Fig. 2, or it may lie on B C (for which case the student can draw the figure for himself).

Suppose A P is a line which bisects the ∠ F′ A C (i.e. divides it into 2 equal parts).

Then this line will cut B C somewhere; let it cut B C at P. Join P F′.

Then in △s P A F′, P A C

A F′ = A C ∵ A F′ is D F, and D F = A C.
A P is common to both △s,
included ∠ F′ A P = included ∠ C A P (constr.)
∴ △ P A F′ ≡ △ P A C (Prop. 5)
∴ P F′ = P C.

Adding B P, ∴ B P + P F′ = B P + P C = B C.

Now in △ B F′ P, B P + P F′ > B F′ (Prop. 12)

∴ B C > B F′,

i.e. B C > E F (for B F′ is E F).

Proposition 16. Theorem

If two triangles have two sides of the one equal to two sides of the other respectively, and if the bases be not equal, then the triangle which has the greater base has the greater angle opposite to it.

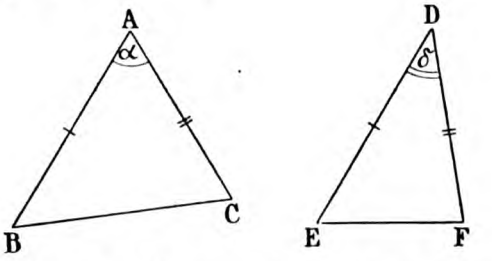
Let A B C, D E F be two △s having

A B = D E
A C = D F
but B C > E F.

It is required to prove that α > δ.

Proof.—One of the following statements must be true:

(1) α = δ
(2) α < δ
(3) α > δ



(1) If α = δ, then △ A B C would ≡ △ D E F (Prop. 5)

∴ B C would = E F.

But B C does not = E F

∴ the statement (1) is not true.

(2) If α < δ then B C would be < E F (Prop. 15).

But B C is not less than E F

∴ the statement (2) is not true

∴ the statement (3) must be true, i.e. α > δ.

Exercise 6

1. In a triangle A B C, A B > A C; D is the middle point of B C.

Prove that ∠ A D C is acute.

2. In a quadrilateral A B C D, A D = B C, but A C > B D; prove that ∠ A D C > ∠ B C D.

3. The sides X Y, X Z of a triangle X Y Z are produced to points S and T respectively, so that Y S = Z T.

Prove that if X Y > X Z, Z S > Y T.

4. In a triangle A B C, A D is drawn perpendicular to B C.

Prove that A B > B D and A C > C D.

5. Prove that the straight line joining the vertex of an isosceles triangle to any point in the base is less than either of the equal sides of the triangle.

6. If one diagonal of a quadrilateral bisects the two angles at its extremities, it will bisect the other diagonal at right angles.

Prove this, carefully drawing the figure.

7. On the sides A B, A C of triangle A B C, equilateral triangles A B D, A C E are constructed externally; C D and B E are joined.

Prove that triangle B A E ≡ triangle D A C.

8. Show that the perimeter of a polygon is always greater than the perimeter of a polygon of which the successive angular points lie on the sides of the first polygon taken in order.

9. On the sides B C, C A, A B of an equilateral triangle, the three equilateral triangles B C D, C A E, A B F are drawn.

Show that D E F is an equilateral triangle.

In working out exercises the student should set out each step with great care, just as in the case of propositions. Figures should be neatly drawn. Then, underneath, should appear a description of the data, i.e. the conditions given in the exercise, followed by what is required to prove. Next should follow the proof itself, fully and neatly written out. Geometry, remember, calls for exactness and precision. M. A. L.

Continued from page 256

BUSINESS AND COMMERCE:

***Contributors*:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).**

COMMERCIAL TRAINING.—V

WITH all the ramifications of business and commerce it is no easy task to explain to the full the thousand and one uses of the card-index system, offering, as it does, an instant and immediate report concerning any individual or firm with whom one does business in any way. With certain classes of trade such a system has become imperatively an integral part of the routine of the office, and a vast store of commercial secrets is docketed away in the drawers under this system.

Modern Methods

Carry the system further in mind and you will realise its possibilities. Every customer, you remember, has a number, and when his letters come to be filed they do not have to be sorted from the alphabetical standard, but in the filing cabinet there are numbered file folders, one for each correspondent, and his latest letter is merely slipped, generally in an upright position so that it can easily be read as it stands, into the folder in the actual order of date received. Obviously, it is far easier and far quicker for a clerk to produce the correspondence of No. 109, say, than it would be to go through an alphabetical index in search of Wilson. Wales & Co., for every drawer in the filing cabinet will contain space for so many numbers, which will be specified on a little tablet outside.

Naturally, the actual systems vary slightly in different offices, but it is the duty of every clerk to make himself acquainted with the broad system, for in present-day businesses there is not much time in which to teach juniors their calling, and a filing clerk, taking up his new responsibilities, will not have very much tuition in the work that lies before him. It is very largely a matter of thinking for oneself, of reasoning things out, and it is the clerk who can improve upon an existing system and throw some of his own personality and individuality into it who is likely to succeed.

With regard to the writing of letters, and the confidential details concerning customers which inevitably filter through from the principals to the clerks, we might well interject a few words concerning the responsibilities of clerks to their employers. Nowhere more than in business is the wisdom of the old saw "Silence is golden" brought home to one, and it is an unwritten rule of business and commerce that the loyal support of every clerk shall be given to those who employ him. No word of gossip or of tittle-tattle should escape the lips of a clerk even in the security of his own home.

Whilst dealing with this phase of business life it will be well if we dip into what might be termed the etiquette of an office. One of the unwritten rules is that a junior shall give way to a senior, and no clerk has ever lost anything yet by being polite to everyone, whether an equal or a superior. Girls in offices, particularly those of the weakly, nervous temperament, are occasionally made the butt of junior male clerks instead of being treated, as they should be, with chivalrous consideration. In present-day offices there is not much time for the niceties of existence, but when it comes to the common courtesies they should be denied to no one.

Office Etiquette

In the principal's room clerks should stand attentively some distance from the employer's desk, and should in no way quiz and pry as though they were trying to see what was upon it. When meeting a superior in the street there is nothing unmanly or servile in the simple courtesy of a junior raising his hat. To knock upon the door of a superior's room before entering is a little compliment that should not be omitted, and among any office staff there should be a feeling of camaraderie, a desire for self-help and mutual well-being.

BUSINESS AND COMMERCE.

The Shareholders (*a*) provide the money which the Board of Directors (*b*) utilise to establish Works and lay down Plant (*d*). In co-operation with the Secretary (*c*), the Cashier (*e*) and the Accountant (*f*), the Advertisement Manager acquires "space" in various publications (*g*) for advertising the goods with which, through the agency of Travellers (*h*), the Consumer (*i*) is supplied at the retail store.

Hygiene to some extent enters into office life. Clerks, for example, who spend six, seven or eight hours at their desk every working day should learn to sit correctly. They should have their heads as erect as possible, their shoulders squared with chests out, and if they can keep their eyes fourteen inches from their work so much the better. So far as possible for everyone's comfort windows should be kept open, and even on cold days directly the atmosphere becomes stuffy fresh air should be admitted, if only for a moment. Among clerks you will see bent-backed, bottle-shouldered fellows and you will also see splendid specimens of youthful manhood, which seems to prove that because one is following a sedentary occupation one need not necessarily develop into a weakling. A sharp walk to the office in the morning instead of rushing over breakfast and hurrying for the very latest tram or train is one antidote to unhealthy clerkship.

Labour-Saving Devices

Apart from the card-index system, which we have just explained, there are many other labour-saving devices used in offices. For the duplication of letters and circulars there are rotary machines that will reel off hundreds of copies in an hour. First, the matter is typewritten on a special paper for transferring to the cylinder, and the rest of the process is so simple that no instruction is needed.

Then there are machines for adding figures, special forms of machines for filling in the long items on digests and analyses of figures. Highly technical in their construction, they are comparatively easy to learn, especially to a clerk conversant with the typewriter, without which no modern office is complete, for not only may letters be prepared far more quickly with the aid of these ingenious machines, but documents of all kinds are far more legible.

The tyro, approaching a typewriter for the first time, may well wonder why the letters are not arranged alphabetically, a, b, c, d, and so on. As a matter of fact, in composition there are certain letters which invariably keep in company, and the scheme of the keyboard is partly to allow for this and partly to arrange the letters so that the fingers of one hand may divide the work equally with those of the other.

Here is the actual keyboard:

q w e r t y u i o p
a s d f g h j k l
z x c v b n m , .

Then there are the capital letters:

Q W E R T Y U I O P
A S D F G H J K L
Z X C V B N M * !

There is also a third set of signs and numerals, thus:

1 2 3 4 5 6 7 8 9 0
¼ ½ £ " ? † - ^ &
( ) / : ' ; — ¾ § _

Naturally, there are keyboards that vary considerably where the signs and symbols are concerned, though the letters will not be varied. In the set of signs and numerals above, a so-called "Literary keyboard" was used. A purely commercial machine would probably substitute a dollar sign $ for the caret; fractions, such as ⅛ and ⅜, for the asterisk and dagger; and the sign %, per centum, for the section indicator on the right of the lower row. The sign @, meaning "at so much," and the two lines =, equals, are also employed sometimes, on certain machines.

In fact, the third set of characters is adaptable to the particular type of business, and is arranged to order when a new machine is purchased. The writer has used machines which have three full stops, one on each case for the last stop to the right in the bottom row. We use the term "case" here in the sense that a printer employs it, when he refers to small letters as the lower case and to capitals as the upper case.

Using a Typewriter

Most typewriters are constructed with one set of twenty-eight stops. Each of these stops is connected with a type-bar, and on each type-bar three signs or letters are to be found, the lower case, upper case and figures. Now the actual printing surface of the paper in use is upon a cylinder. When the cylinder is at its normal position the lower case prints. At the side of the machine, however, are two extra stops, marked respectively Caps., and Figs. By depressing the Caps. sign to its full extent, and then striking a letter, a capital is printed, for the cylinder has been lowered by the movement. Depress the Figs. sign fully and the third row of characters is brought into operation, for this level lowers the cylinder still further.

Having thus briefly inspected the machine we can proceed to the more practical side—how to use the machine. This shall be our next consideration. A. B.

CHOOSING A CAREER.—V

Emigration—(*continued from p.* 253).

CANADA.—The land settler in Canada must first of all thoroughly equip himself with a practical knowledge of farming, such knowledge to have been obtained partly in agricultural pursuits in the Mother Country and to some extent by actually working in the Dominion, either as a learner or paid servant, according to circumstances. In any case, it would be useless to rent or purchase land with any hope of success without first obtaining experience in the local conditions that pertain.

In certain parts of Canada land may actually be obtained for the asking. Thus, in Manitoba, Saskatchewan and Alberta, any male above eighteen years of age, who is a British subject, may, upon paying a fee of £2, receive a free grant of 160 acres of land, upon condition that he cultivates it and erects upon it a homestead. This land is not to be acquired whilst resident in the United Kingdom, but has to be applied for at a Land Office in the particular province. In Quebec, Ontario and New Brunswick, from 100 to 200 acres of forest land may be obtained on very similar terms, but, of course, the land has to be cleared before it can be efficiently farmed.

Cost of Living

In all the provinces land may be purchased outright, and improved farms, that is, farms upon which a certain amount of labour has been expended, may be bought in Saskatchewan, Manitoba and Alberta, or be rented. When land is to be purchased the price may almost invariably be paid by instalments.

But in addition to the obtaining of land by purchase or hire, the settler will require capital for the purchase of stock, seeds, implements, and the other paraphernalia of his calling, besides possessing enough to erect a house, and a balance on which to live in the meantime, for returns will not begin to eventuate for many months. Certainly £100 is a very trifling capital upon which to embark with an ordinary holding, and £300 would be none too much; with ranching, however, where there is a large initial stock to be bought, £450 is the minimum sum.

The cost of living in Canada is not so greatly in excess of that in the Mother Country as most people suppose. Luxuries are certainly far more expensive, and clothes are dearer, but the necessaries of life are, if anything, cheaper. Wages are generally higher, and the following figures will give a fair idea of the average rates paid, though it is only fair to state that the hours of labour are usually longer than those at home: Farm hands in the Eastern Provinces, from £5 to £7 a month, with board and lodging, from May to November; about £2 10s. a month in the winter, though many of the hands migrate to the towns during this season. In British Columbia, from £5 to £7 a month, with board and lodging, on long engagements; during the great rush of work skilled harvest men will be able to earn from 6s. to 10s. a day, with board. Married couples are wanted everywhere, and, in addition to a house and a plot of land, will earn from £50 to £90 a year.

Opportunities for Women

So far as women are concerned they are eagerly sought for in all parts of Canada. A wife to the Canadian settler is of paramount importance, not only for companionship, but also for active co-operation in the side-lines of his calling, and domestic servants are in demand everywhere. In Canada, too, lady helps who will take a practical hand in the work of the place as well as caring for children are much wanted, and can depend upon earning from £3 to £4 a month, and be treated as one of the family. Laundresses, cooks, milliners and dressmakers need not fear that they will experience difficulty in finding employment at good wages in almost any part of the Dominion.

Turning for a moment to the professions, it follows naturally that in a swiftly-developing country such as Canada there must be constant openings for those who follow callings other than those connected solely with the land. Generally speaking, appointments are only to be obtained by applicants on the spot.

Solicitors and barristers qualified at home are entitled to set up in practice in most of the provinces after residing a certain time in the province, and paying fees to the local society, or submitting to an examination. Very much the same rules cover chemists and druggists, dentists and doctors. Examinations for the Civil Service of the Dominion of Canada are conducted by the Civil Service Commission, at Ottawa, and application may be made to the secretary of that body for the latest regulations.

Applications for admittance to the Royal North-West Mounted Police can only be made in Canada, though the *High Commissioner for Canada* at 17 *Victoria Street, London, S.W.*, will answer inquiries. The

Adjutant of the force, to whom application should be made, should be addressed at Regina, Saskatchewan. Constables in this force receive about 5s. per day, and sergeants from 8s. to 10s.

No one should entertain the idea of emigrating to Canada unless he or she goes with some definite plan as to the future. Clerks, unless they are proficient shorthand writers, shop assistants and governesses are three types of worker who are not wanted, as they would have practically no chance of securing employment. So far as is possible, also, every emigrant should set out with the knowledge of some definite place or person to whom he or she may go, and the days of promiscuous emigration in the hope of something "turning up" have long since passed.

Travelling Expenses

The fare from England to Canada, i.e. from port to port, varies considerably, but may be ascertained through any shipping agent, and the best time of all to arrive is in the spring, early in April for preference, unless one is going to a definite post. No special outfit of clothes is necessary, unless one makes the passage in the winter, when an abundance of warm attire will be imperative. Emigrants, however, should take all the clothes they possess.

A word of caution.

When seeking advice as to prospects in Canada, consult only disinterested, reliable people; those who would benefit from a commission on your passage ticket should not be allowed to influence you unduly. It would be far better to write for official statements to *The Chief Clerk, Emigrants' Information Office*, 34 *Broadway, Westminster, London, S.W.*, from whom a handbook on Canada may be obtained; or to the *Emigration Branch, Department of the Interior Government of Canada*, 11 *and* 12 *Charing Cross, London, S.W.*

AUSTRALIA.—The Commonwealth of Australia is twenty-four and a half times as large as England, Scotland, Ireland and Wales together. It includes nearly three millions of square miles of territory, and is divided into six separate States, New South Wales, Victoria, South Australia, Queensland, Western Australia and Tasmania.

As a matter of fact, to review Australia as a suitable field fo emigration requires an immense amount of pains aking effort. One must bear in mind that this vast country is peopled by a young and forceful nation, with its own individuality and characteristics. Australia is not a country merely peopled by folks who have gone out from the Motherland; it has its own native-born population, whose ideas are the ideas that count.

According to the advertisements, only settlers, farm workers and domestic servants are required in the Commonwealth, but, because this class is the only one sought officially, one must not be obsessed by the notion that other emigrants will not find an opportunity of getting on.

It follows, obviously, that doctors and estate agents, motor-car manufacturers, insurance experts, chemists, railway workers, advertisement specialists, lawyers, photographers and members of all the other trades and professions must be required. The point, however, is that no one who follows any of these callings should go out to the Commonwealth in the happy-go-lucky way of the farm worker, who can be certain that his services will be soon snapped up.

As with every other method of earning one's livelihood, emigration calls for the work of preparation. Young professionals or youthful business men or business women who contemplate setting up in Australia should spend much time in becoming acquainted with conditions in the Commonwealth. They should write to the Agents-General of the various States (whose addresses are given later) and they should also put themselves in touch with experts actually residing in Australia.

50,000,000 White Settlers

When in possession of the promise of employment there can be little reason to doubt but what in our great overseas dominion there are splendid possibilities.

According to one authoritative statement there is room in the Commonwealth for no fewer than fifty millions of white settlers, but in Australia, no less than in Canada, farmers and those who will derive their living from pastoral pursuits are the colonists for whom there are the brightest opportunities. Clerks, shopmen and warehousemen should not emigrate unless they actually have positions to which they can go.

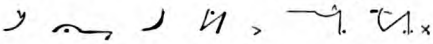
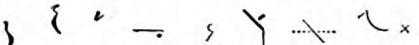
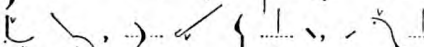
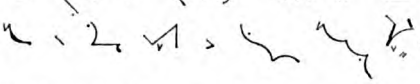
Men with a knowledge of farming, stock-keeping, sheep and agricultu e generally, and women who understand dairywork and the management of poultry, are the most likely to succeed in the Commonwealth, and though those with sufficient capital may go out and occupy a holding at once, there is just as much opportunity for the worker—the young man or young woman who will both learn and earn. A. C. M.

SHORTHAND.—IV

Key to Exercise 17.

1. *They*-will-*be at* Ivy Road *by* five *on-the*-fourth *of*-July.
2. *I-saw you at-the* Tower *with* Isaac Bowers *and* Tom Powell.
3. *What would you give us to see-the* rare egg *of-the* auk ?
4. *When do-you* hope *to-have-the* calico *you* bought *on-the* ninth *of*-March ?
5. *He saw us by-the sea, and so he*-will-*be* ready *with-the* tale *of-the* refugee.
6. *He*-will-*have-the* bill ready *when you-come to-the* village *on*-Monday.
7. *I*-am *happy to-be up and out to* enjoy *the* pure air.
8. *I-have-had to buy a* new pouch *and* pipe *at-the* shop along-*the* Avenue.

Key to Exercise 18

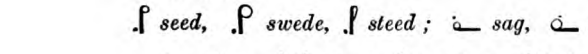
1.
2. 
3. 
4. 
5.
6. 

Initial Circles and Loops.—The most frequently-occurring letters in the English language are represented in Pitman's Shorthand by circles, loops and hooks attached to strokes, and the circles and loops are now to be dealt with. Look at the following forms—

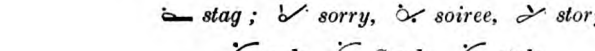
Here there are a small circle, a large circle, and a small loop on the right-hand side of a downstroke. The small circle stands for *s*, the large circle stands for *sw* (swā), and the small loop stands for *st* (stē). The three outlines above, then, represent respectively the words—

soup, swoop, stoop.

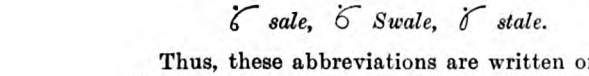
Note that the circles and loop are read first, that is, they are initial. Further examples are as follows—



seed, swede, steed ; sag, swag,



stag ; sorry, soiree, story ;



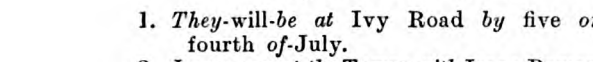
sale, Swale, stale.

Thus, these abbreviations are written on the right-hand side of downstrokes, above horizontals and upstrokes, and inside curves. The *sw* circle should be made distinctly large, and the *st* loop one-half the length of the stroke to which it is attached.

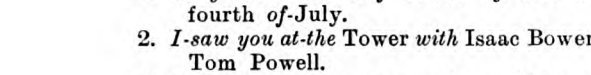
Exercise 19

GRAMMALOGUES

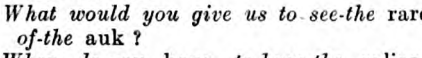
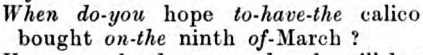
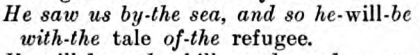
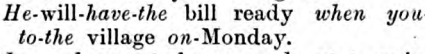
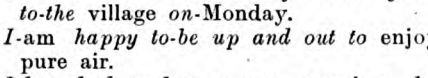
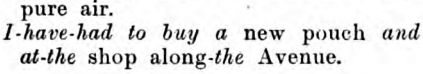
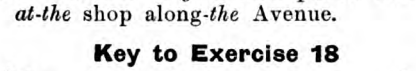
as, has, is, his ; are, our ; or,



your, year ; in, any, no, know,



own ; my, me, him, may.

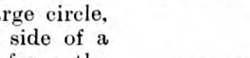
1.
2. 
3. 
4. 
5. 
6. 
7. 
8. 

Key to Exercise 19

1. sop, swop, stop, save, suave, stave, seal, sweal, steal.
2. sorrow, swarthy, starry, sage, swage, stage, sane, swain, stain.
3. *You-are to*-sell *our own* coffee *to-the* Swiss.
4. *It-is his* duty *to know-the* value *of-the* sago *and-the soap.*
5. *You-may see him at-the* store *with my* car.
6. *You*-will-*see me each* Saturday *or* Monday *at your* villa.
7. *As-the year is going by, I-shall* take *in* " *The* Monthly Star."
8. *He-has to*-go *as* long *as he-can to-the* academy.

Deal with this key as previously suggested.

Final Circles and Loops.—Not only are these abbreviations used initially, but they may be written finally, as follows—



Note that the circles and loop are on the same side as the initial forms. These outlines represent respectively—

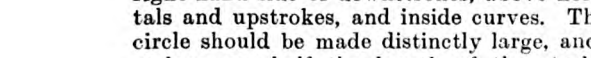
pass, passes, past.

The small circle and the loop represent the same letters as when written initially. The large final circle represents the syllables *ses, sez.* Carefully follow these examples—

toss, tosses, tossed ;

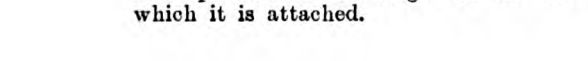
loss, losses, lost.

Besides the small final loop, there is also a large final loop for the syllable *ster ;* thus—



chest, Chester ; mast, master.

Circle *s* may be added, as in—

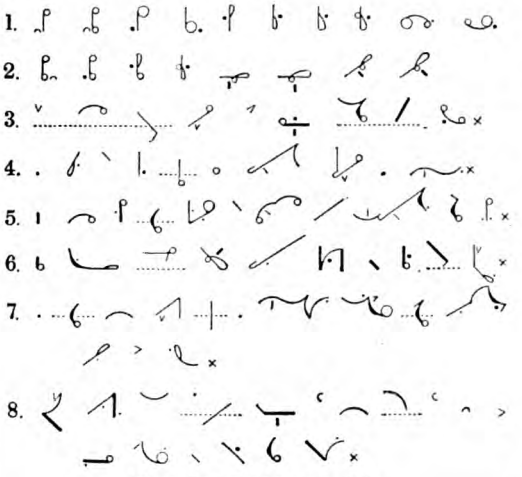


post, posts ; poster, posters.

Exercise 20

GRAMMALOGUES

because; itself; those, this, these, youths, thus; myself, himself.



Key to Exercise 20

1. suit, suits, sweet, teases, state, taste, taster, tasters, swims, sneezes.
2. stews, seats, states, tastes, coasts, coasters, roasts, roasters.
3. *I myself put-the* rice *and-the* sago *in-those large* safes.
4. *The* chest *of* tea *itself is* worth twice *the* money.
5. *He himself* said *these* terraces *of* slums *are* unworthy *of-this* city.
6. *He-is* vexed *because-the* posters were delayed *two* days *by-the* typist.
7. *The youths may* write *out the* monthly invoices *and-thus* relieve-*the* rest *of-the* staff.
8. *I-shall-be* ready *in an hour to*-go *with him or with you to-the* Gas Offices *to* pay *this* bill.

There is a class of words to which the student should give his attention, of which the following are examples—

analysis, census, exercises.

Here, in each case, a sign is inserted within the large circle to express a vowel, other than *ĕ*, coming between the two *s*'*s* represented by the large circle.

Medial Circles and Loops.—Any of these abbreviations can be used medially, as follows—

task, risk, husk, citizen, raisins, mason, unseemly, possessive, exhaust, excessive, adjusting, enlisting, elastic, masterpiece.

Medial Vowels.—An unaccented short vowel, in the middle of a word, may usually be omitted, and students should cultivate the habit of recognising at once outlines in which such short vowels are omitted; thus—

cousin, reason, oxen, officer, recite, business.

Vowels and S and T.—An important rule to remember is that an initial or a final vowel requires an initial or a final stroke; thus—

set, Esta; less, lessee; spy, espy; noise, noisy; dust, dusty; rust, rusty.

NOTE: *steady, study.*

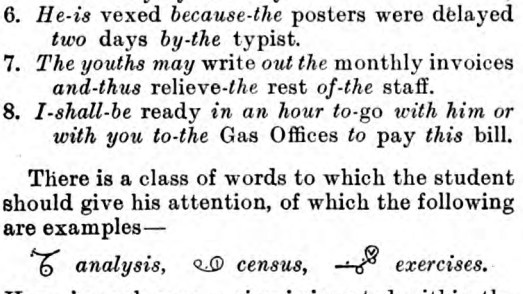
When a vowel occurs between *s* and *t*, the *st* loop cannot be used, nor can the *ster* loop be written when a prominent vowel occurs in a syllable; thus—

best, beset; poster, posture; investor, vesture; restore.

Exercise 21

GRAMMALOGUES

themselves; ourselves; special-ly, speak; subject-ed; suggest-ed; several, saviour; we, way.

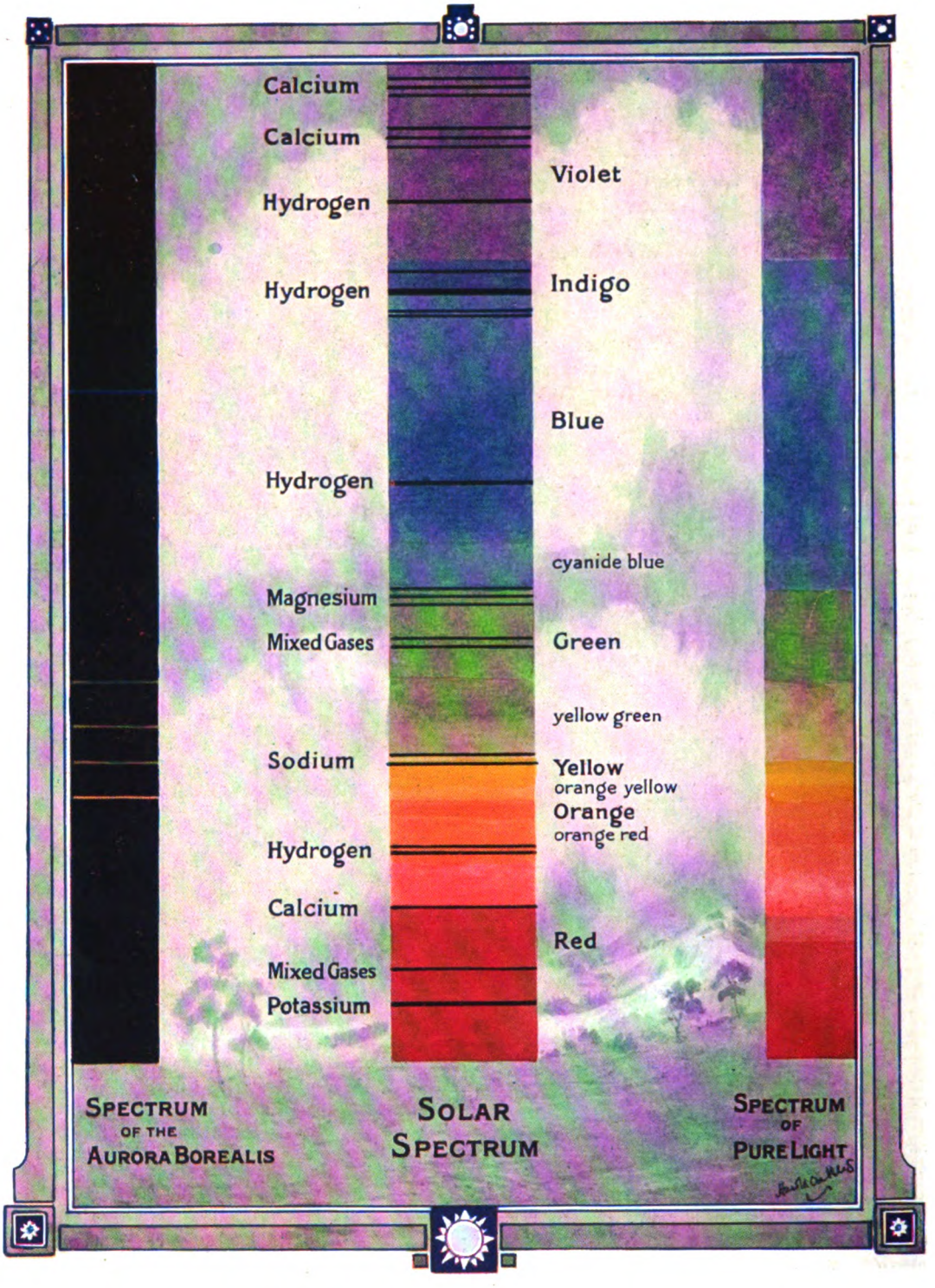


Exercise 22

GRAMMALOGUES

first; influence; influenced, next; most, must; Lord; language, owing, thing, young.

1. *Owing to-the* disposal *of-our* business *we-are having a* sale *on-the first of next* month.
2. *He influenced the young*-fellow *to* study *the* Japanese *language.*
3. *The next thing you-must buy is a* book-case, *and-it-should-be most* useful *to-you.*
4. *His* life *was*-now exceedingly worthy *owing to-the influence of* Pastor Doncaster.



Any prism of cut glass is sufficient to give a good Solar Spectrum. Hold the prism close to the eye, the edge parallel to a slit in a door, and look at the Sun through it. (*See page* 351.)

Continued from page 264.

ENGLISH LANGUAGE AND LITERATURE:

Contributors:—ENGLISH LANGUAGE (W. A. Craigie, M.A., LL.D.; E. W. Edmunds, M.A.). ENGLISH LITERATURE (John Derry, J.P.). PHILOSOPHY (E. H. Tripp, Ph.D.). POLITICAL ECONOMY (J. W. Urwin). ETHICS (W. H. Koebel). PUBLIC SPEAKING (J. W. Urwin).

FIRST STAGES IN ENGLISH PROSE

HAVING traced the main stream of English poetry to its first considerable expansions in the humanism of Chaucer and the poetical idealism of Spenser, we turn back and follow the beginnings of English prose.

It may be asked why the story of prose follows the story of poetry. Seeing that prose is the simpler form of writing, in the natural language of all of us, why should it not be placed first?

Our subject is *literature*, or that part of the writings of each age which lives long, by virtue of its interest, value, or charm; and these qualities are found but rarely in the early stages of the prose of any language, whereas they are inherent in all true poetry. Poetry sings, and so haunts the mind, and is remembered. Whatever emotion is so fine as to be felt deeply, repays the trouble of expression in poetic forms; nay, it demands such expression. But prose long remains the language of the commonplace.

Latinised Jargon

It was natural that our distant forefathers should make their prose writing too elaborate. Learning was then the privilege of a class, whose written language was Latin; and Latin had its own impressive literature. When the time came for using the common English tongue for writing, the scholarly men of that day instinctively imitated the formal classical models they had been taught to admire.

Then, too, early writings were chiefly translations, which suggested imitation of old styles, and caused roundabout language to be used rather than simple idiomatic speech.

Hence a wide divergence took place between spoken and written English, and in part that divergence remains to this day. A great deal of early English prose was a Latinised jargon, just as to-day there is a scientific jargon, a legal jargon, and a literary jargon. But though prose readily follows bad models, and sinks into bad sectional fashions, as in these jargons, it has, on the whole, gradually attained simplicity, clearness, and a variety adapted to all kinds of uses.

Seeing how pleased men are with a dull formality in writing, one shudders at the thought of what might have happened to our language if, from the first, there had not been a preservative influence at work bringing us back to a central purity. That influence has made itself felt through the English translation of *The Bible*.

The English Bible

The Bible offers a wonderful variety of thought, emotion, and experience, for expression in words understood by all. It demands dignity and elevation, with simplicity. In the English translation that ideal has been attained in such a remarkable degree that the book, more than any other influence, by its universal appeal, has helped to keep our language pure, unhampered, in the main, by the pedantry of the learned, and unvulgarised by the slang which mediocrity welcomes in spasms of fashion.

A very short reference to pre-Biblical prose will suffice. It may be said to have been begun in England by King Alfred. Before his day, it is true, there were some desultory translations into the vernacular from the Latin Gospels, as in the case of The Venerable Bede's version of *St. John*. The Saxon *Chronicle* had also been begun. But there was no body of Saxon prose such as Alfred created. He realised the need for

all to have knowledge, and he saw that knowledge could only be popularised in the national tongue. A large part of the prose he caused to be produced brought to his countrymen borrowed material, through translation.

Thus, for religious uses, he translated Gregory's *Pastoral Care*. It was prefaced by a defence of writing in English. Then he paraphrased, with additions, the *Universal History*, by Orosius. *The Consolation of Philosophy*, by Bœthius, and Augustine's *Soliloquies* were also translated. These were all popular books of that day in their Latin form.

Bede's invaluable *Ecclesiastical History*, English in authorship and subject, was now made accessible in the English tongue. And, lastly, Alfred caused the Saxon *Chronicle* to be recast, brought up to date, and restarted with an impetus which carried it forward until the fourteenth century, when the translation of the Bible began to fix and steady the changing language.

While Alfred's translations have a historical value, they do not form part of the literature which now appeals to us as English. The man who founded modern English prose was John Wycliffe, when, by his influence, he caused the whole of the Bible to be translated from the Latin *Vulgate*.

Through his influence, the Bible was translated, more than 150 years before it was *printed* in English, and more than 200 years before it had attained the beauty of diction which has made it the choicest model for English prose (*see* the double-page illustration, pp. 200, 201).

John Wycliffe

The Wycliffe translation in its first form —for there were two editions—was cumbrous in expression, and in its improved form it was far less easy and melodious than the noble version which has reached us from a much later date, when the translation was made from the original Hebrew and Greek and not from the Latin. Nevertheless, it may fairly be claimed for Wycliffe that he founded our modern prose, inasmuch as he produced in it the first book that was great literature and has retained a lasting influence.

John Wycliffe was a Yorkshireman, born near Richmond, about the year 1320. Educated at Oxford, he rose to be, first, Master of Balliol, then recently founded, and, later, Warden of Canterbury Hall, the equivalent of the present office of Dean of Christ Church. In 1372 he was appointed Professor of Divinity.

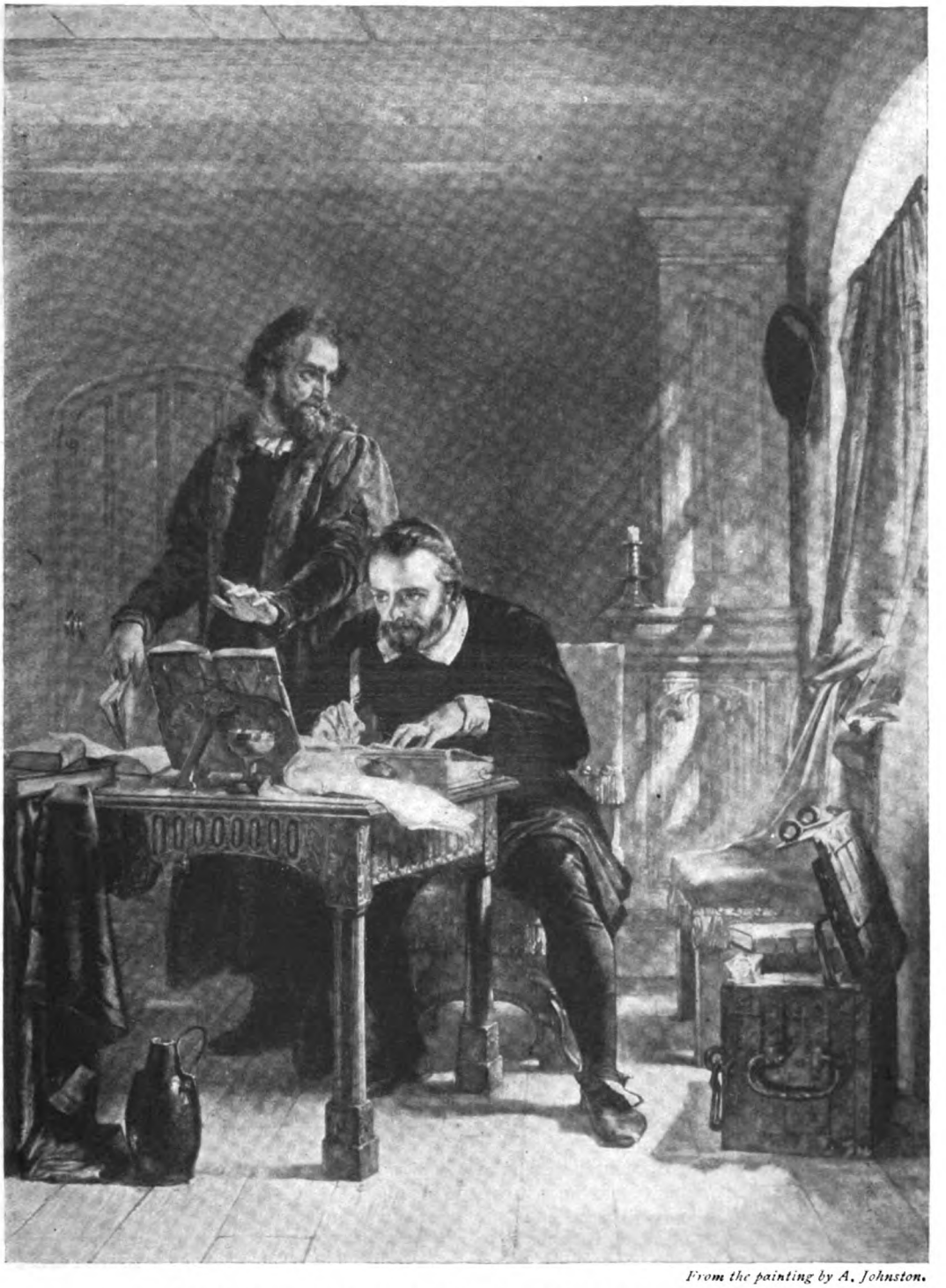
A man of fine independence of mind, bold and sincere, he became the dominating personality of the University, and eventually wielded an almost national influence. As an objector to the payment of English ecclesiastical revenues to Catholic officials outside England, he was supported both by Court and University influences. His views as to the place of the Bible in religion were progressive. He held, first, that the book should be in the hands of the laity in English; then, that the Scriptures were an authoritative guide for the Church; and, at last, that they do not warrant some of the doctrines of the Roman Catholic faith, as, for example, transubstantiation. To a large extent, this was the position taken up in Tudor times by the Protestants.

The Lollard Movement

For these views, Wycliffe was called to account by the Church on several occasions, and finally was banished from the University, but was suffered to end his days peacefully as Rector of Lutterworth, in Leicestershire, in 1384. His translation of the Bible was made with the assistance of a band of followers, the most conspicuous being Nicholas of Hereford and John Purvey. The revised and greatly improved edition was apparently the work, to a large extent, of Purvey, who was associated with Wycliffe at Lutterworth, and completed the revision after his master's death.

The circulation of the Scriptures in English accompanied a popular movement by bands of "poor preachers" who had adopted Wycliffe's views, and the religious agitation that followed became known, derisively, as Lollardism. Thus, the circulation of the Wycliffe Bible was linked with the spread of unauthorised beliefs, and indeed the new translation, with comments and glosses, tended to support those beliefs. Hence the campaign of suppression which ensued after Wycliffe's death. The translation of the Bible was forbidden. Wycliffe's version was condemned and seized. The Reformer's remains were disinterred and burned, and the ashes cast on the waters of the little stream that runs through Lutterworth.

To a large extent the Lollard movement was crushed; but, still, Purvey's edition of the Bible text was quietly copied and circulated in England; and, abroad, Wycliffe's Latin writings were widely reproduced, and in Bohemia stimulated the reform movement associated with the life and martyrdom of John Huss, the spiritual hero of the Czech race.



From the painting by A. Johnston.

WILLIAM TYNDALE (1484–1536) TRANSLATING THE BIBLE.

Like Wycliffe, an Oxford man, Tyndale had one great advantage over Wycliffe, who lived 100 years earlier: he was able to translate from the original Greek and Hebrew, a knowledge of these languages having by his time reached the Universities.

It may be convenient to complete here our reference to the English Bible, though it will carry us to near the end of the period we are considering.

Just a hundred years after the death of John Wycliffe, William Tyndale was born in Gloucestershire. He too was educated at Oxford, and, like Wycliffe, became possessed by the idea of giving every Englishman the chance of reading the Scriptures in his native tongue. Printing had now been introduced, but Wycliffe's Bible had not been printed. Indeed it did not appear in that form until the middle of the nineteenth century, 466 years after Wycliffe's death.

By the time Tyndale was a student at Oxford a knowledge of Greek and of Hebrew had reached the universities, thus translations could be made direct from the languages in which the Bible had been originally written. It was no longer necessary for the English Bible to be a translation of a translation of St. Jerome's Latin version, known as the "Vulgate."

Tunstall, at that time Bishop of London, was a fine scholar and had been a friend of Erasmus, the compiler of the Greek Testament and stimulator of the study of Greek at Cambridge. To Tunstall, therefore, went Tyndale, fired with the idea of an accurate translation of the New Testament.

He received no encouragement, however. In his own words, "Not only was there no place in my lord of London's palace to translate the New Testament, but also there was no place to do it in all England."

Martyrdom of Tyndale

Assisted by a London alderman, Humphry Monmouth, who had been attracted by his preaching in the old church of St. Dunstan-in-the-West, Tyndale passed over to Germany —then, comparatively, the home of freedom —and there, in 1525, produced his English New Testament. Its arrival was anticipated in England, where it was officially condemned as "pernicious merchandise," and it was publicly burned in St. Paul's Churchyard by order of Bishop Tunstall.

Tyndale stayed abroad, translated the Pentateuch and other parts of the Scriptures, but not the whole Bible, before he suffered martyrdom at Brussels, in 1536, praying with his dying breath that the eyes of King Henry VIII might be opened to see the value of a free Bible.

In the year 1535 the scholarly Miles Coverdale, who had probably worked with Tyndale abroad, and later became a bishop, issued in London his translation of the whole Bible, the first complete and printed Bible, "by the King's most gracious licence."

During the next seventy years, various editions and revisions of the Scriptures were published, but all, down to the so-called "Authorised Version," issued by a body of forty-seven translators in 1611, were based substantially on Tyndale and Coverdale, who had themselves used Wycliffe for reference.

The foundations of the English translation of the Bible having been laid so well and truly by Tyndale, only the ornaments of a chaste style were left for additions by subsequent revisers, and the restraint and taste shown by the board of editors who produced the Authorised Version have retained the grateful admiration of readers for three hundred years. "Shaped by study and piety, in suffering, the book, beyond all others, has formed the very kernel of our English speech and literature."

An Early Book of Travel

The only English prose work that calls for mention here as coming to us from before the time of Wycliffe is the *Voyage and Travel* of Sir John Mandeville. It was supposed to be written in French by an Englishman, and told of adventures in all parts of the then more or less known world.

Translated into English about the year 1356, with a charming simplicity and ease in narration, it remained for centuries the most popular book of travel. Really it was a clever digest of stories of travel, gleaned from ancient and mediæval literature, probably by one Jean d'Outremeuse, a stay-at-home writer of Liége. The writer had a power of creating the illusion of reality, when retailing wonders to the simple-minded, that since has only been equalled by Defoe and Swift; and the world has been slow to believe that there never was a travelled Mandeville.

As an example of the Mandeville style of narrative we quote a description of the Festival of Juggernaut, which continued true far into the nineteenth century.

And ye shall understand that when great fests and solemnities of that idol be, all the country about meet there together, and they set this idol upon a car with great reverence, well arrayed with clothes of gold—rich clothes of Tartary and Camacia and other precious cloths—and they lead him about the city with great solemnity. And before the car first in procession go all the maidens of the country, two and two together, full orderly; and after the maidens go the pilgrims; and some of them fall down under the wheels of the car, and let the car go over them, so that they be dead anon; and

some have their arms and their limbs all broken, and some their sides; and all this do they for love of their god, in great devotion. And they think that the more pain and the more tribulation they suffer for love of their god the more joy they shall have in another world. And, shortly, they suffer so great pains and so hard martyrdoms for love of their idol that a Christian man, I trow, durst not take upon him the tenth part for love of our Lord Jesu Christ.

It will be seen that by the middle of the fourteenth century English prose admitted of clear and vivid narration.

Contemporaneous with Wycliffe's writing, we have four examples of Chaucer's prose. They are his *Tale of Melibeus*, a conversational narrative abounding in quotations, and his *Parson's Tale*, an undisguised sermon, from the *Canterbury Tales*; his translation of the *Consolation of Philosophy* by Boethius; and his *Treatise on the Astrolabe*, an abstruse lesson for his little son Lewis. The subjects are, for the most part, heavy, and do not allow popular treatment, but the poet's prose, though rather cumbrous, shows that the language was being adapted for a wide variety of uses. Still, Chaucer would not be known to succeeding ages by his prose writings if they stood alone.

From the portrait in the possession of the Rt. Hon. the Earl of Denbigh.

JOHN WYCLIFFE (1320-84)
can fairly be called the founder of modern English prose.

The barren interval between the age of Wycliffe and the age of Tyndale, that is the whole of the fifteenth century, only produced one great prose work, Sir Thomas Malory's *Morte d'Arthur;* though there are three authors belonging to the period, besides Malory, who may be given passing mention.

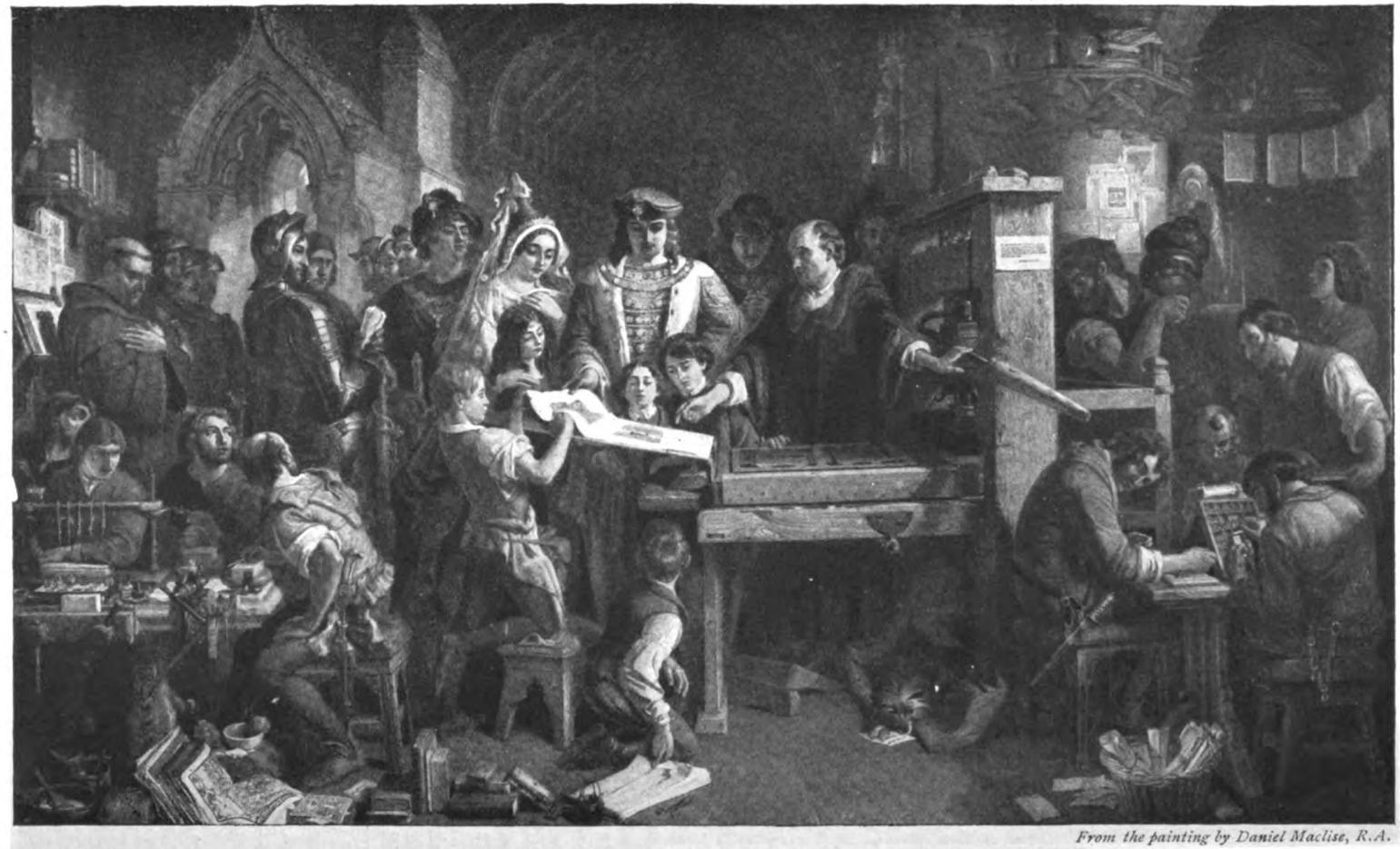
Reginald Pecock, who rose to be Bishop of Chichester, but was deposed for heresy, and died under a cloud in confinement about 1460, wrote, in the middle of the century, *The Repressor of overmuch blaming of the Clergy*, a defence of the Church against the Lollard followers of Wycliffe. His book was the first philosophical disquisition in English prose. Pecock was a conceited man, immensely proud of his own intellectual ingenuity, and the result was that he equally offended those whom he attacked and those whom he supported. His *Repressor*, however, marks an extension in the scope of the English tongue.

The *Paston Letters*, which belong to the same period (1424 to 1506), are a family correspondence, that throw much light on the family and social life of the century. They are not literature, but only letters that passed in familiar intercourse when writing by women was a laborious task; but they give clearer glimpses of the life of country gentry during the Wars of the Roses than can be gained through any other record.

A literary influence of the fifteenth century that cannot be disregarded is the work of William Caxton, the printer, beyond his craft of printing. He was of Kentish birth, served his apprenticeship to a London mercer, and then started business on his own account in Bruges, where he lived for thirty years. In 1471 he finished a translation of a French romance, *Le Recueil des Histoires de Troye*, and printed it in Bruges, probably in 1474. There was a great demand for this work—the first book printed in English—and to meet the demand, Caxton went into the printing business.

At Michaelmas, 1476, he removed to Westminster and became the first English printer in England. The first book printed here was *The Dictes and Sayings of the Philosophers*, a translation by Earl Rivers of a French book.

From this time onward, Caxton was equally busy with translation and with printing. He translated twenty-one books and printed eighty. Among the volumes issued from his press were works by Chaucer, Lydgate, and Gower, and, above all, Malory's *Morte d'Arthur*, a gem of English literature.



From the painting by Daniel Maclise, R.A.

THE BEGINNINGS OF PRINTING.

William Caxton showing the first specimen of his work to King Edward IV. at the Almonry, Westminster, where, in 1476, he established himself as the first English printer; he catered not so much for the learned as for the well-to-do general public and, in all, produced eighty books, including twenty-one translations by himself.

Caxton did not cater primarily for the learned, but for the general public who could afford books—the nobles about the Court and the merchant class. His aim was to make a popular selection, and he had a shrewd idea as to what would sell.

Though his critical taste was sound, as is shown in his discriminating praise of Chaucer and of Malory, his own style lacked literary distinction. His attitude was that of the modern journalist who makes an impression by fluent and enthusiastic good sense mellowed by humour, but is too busy to attempt close condensation or wait for literary polish.

The book *Le Morte d'Arthur* is only known to us through Caxton's press. No manuscript of it is in existence. Caxton printed it "after a copy unto me delivered, which copy Sir Thomas Malory did take out of certain books of French, and reduced it into English."

Malory tells us clearly when the book was written. In an epilogue he says:

> This book was ended the ninth year of the reign of King Edward the Fourth [March 4, 1469, to March 4, 1470], by Sir Thames Malory, Knight, as Jesu help him for his great might, as he is the servant of Jesu both day and night.

Caxton also tells us when it was printed:

> Which book was . . . . by me divided into twenty-one books, chaptered and enprinted and finished in the Abbey, Westminster, the last day of July, the year of our Lord 1485.

It is not certainly known who Malory was, but, in all probability, he was a supporter of the Lancastrian cause who was exempt from pardon at the close of the Wars of the Roses, and wrote the book as a pastime while he was in prison; and that he died within a year of making his request for the prayers of all for a "good deliverance."

The Arthurian legends, which had originated in Wales, were developed through centuries by the poetical instinct of France, but, at the time when Malory lived, the chivalry they enshrined had faded away into a faint afterglow. That there was much accumulated in this nebulous mass of romance which deserved perpetuation, is shown by the charm it has held for poets of a later day.

Milton contemplated Arthurian chivalry as the subject of his masterpiece, before he decided on *Paradise Lost;* and Tennyson built on it his longest connected work. It was Malory who, once for all, gathered the legends into one compact treasure-house—his book. He seems to have collected as many of the French stories as he could find centring on the Round Table companionship. These he paraphrased, with additions on his own account, in a prose narrative saturated with romance, and distinguished by a diction of extraordinary beauty and vividness.

As an illustration of Malory's style we may quote from the last scenes in Launcelot's story:

> Then Sir Launcelot never after ate but little meat, nor drank, till he was dead. For then he sickened more and more, and dried, and dwindled away. For the bishop, nor none of his fellows, might not make him to eat, and little he drank, that he was soon waxed shorter by a cubit than he was, that the people could not know him. For evermore, day and night, he prayed, but sometime he slumbered a broken sleep; and ever he was lying grovelling on the tomb of King Arthur and Queen Guenever. And no comfort that the Bishop, nor Sir Bors, nor none of his fellows, could make him availed.
>
> So, within six weeks after, Sir Launcelot fell sick and lay in his bed; and then he sent for the bishop that there was an hermit, and all his true fellows. Then Sir Launcelot said in dreary steven: "Sir bishop, I pray you give to me all my rites that belongeth to a Christian man." "It shall not need you," said the hermit and all his fellows, "it is but a heaviness of your blood, and ye shall be well amended, by the grace of God, to-morrow." "My fair lords," said Sir Launcelot, "wit ye well, my careful body will into the earth. I have warning more than I will now say. Therefore, give me my rites." So when he was houseled and anealed, and had all that a Christian man ought to have, he prayed the bishop that his fellows might bear his body to Joyous Gard. Some men say it was Alnwick, and some men say it was Bamborough.
>
> And so within fifteen days they came to Joyous Gard; and there they laid his corpse in the body of the quire, and sang and read many psalters and prayers over him and about him; and ever his visage was laid open and naked that all folks might behold him.

Such writing, nearly four hundred and fifty years ago, served equally with the noblest strains and most vivid narratives of the English Bible to preserve the purity and beauty of the English tongue.

From the period that gave us Tyndale's Bible, two other books must be singled out—the translation of Froissart's *Chronicle* by John Bourchier, Lord Berners, an excellent rendering of a work of great historical value. Another is Sir Thomas Elyot's *Governour*, the first English book on education. Elyot set out to demonstrate how a statesman should be trained, but his aim broadened as he wrote, and the book may be accepted as setting the highest standard of moral culture as it was understood by the most enlightened men of the age. J. D.

THE ENGLISH LANGUAGE.—IV

PRONOUNS are classified as personal, reflexive, demonstrative, relative, interrogative, indefinite.

The personal pronouns are so called because they are special to the three persons: *I* (first person); *thou* (second person); *he, she, it* (third person). Their special forms in the accusative and genitive are familiar. The genitive forms, *my, his, your*, etc., are really adjuncts of the noun, and are often spoken of as possessive adjectives. The addition of the word *self* produces the reflexive pronouns *myself, yourself, himself, ourselves*, etc. These may be used merely for emphasis as in (i) where *myself* is an adjunct of the subject *I*, or in order to reflect in the object the same person or thing as is mentioned in the subject (ii).

(i) I did the work *myself*. [Emphatic.]
(ii) The dog hurt *itself*. [Reflexive.]

Relative and Demonstrative Pronouns

Certain pronouns refer back to, or point out, a noun or pronoun which has previously been expressed (known as their *antecedent*); such pronouns are called *demonstrative*, except when they also serve to join sentences together, when they are known as *relative* pronouns. The chief demonstrative pronouns are *this, that, these, those, such, same, one*—e.g.:—

(i) I like *this* better than the *one* you have.
(ii) *That* is very good.

The relative pronouns are *who, which, that, wha , as*, and the compound forms *whosoever*, etc. Most of these words may belong to other groups of pronouns, and *that* and *as* may belong to other parts of speech. In order to be a relative pronoun, a word must have a definite antecedent and at the same time serve as a joining word. A sentence commencing with a relative pronoun acts as an adjunct to a noun or pronoun—e.g.:—

(iii) I have a friend who lives in London.

The complete sentence *who lives in London* is an adjunct of *friend*.

Both demonstratives and relatives agree with their antecedents in number, person and gender; but they have their own case. Thus in (iii) *who* is singular, third person and masculine, to agree with *friend*, but is in the nominative case as subject of *lives*, while *friend* is objective. Confusion between *who* (nom.) and *whom* (obj.) often arises through inattention to this, as in (iv) and (v):—

(iv) I don't know who you spoke to [*whom*: obj. after *to*].
(v) These are the boys whom I think have your book [*who*: nom. subj. of *have*].

A few further errors in the use of the relative may be illustrated:—

(vi) He is one of the best men who *has* ever sat in the House [have].
(vii) He came to see me in London, which cost him a great deal.
(viii) He has splendid talents, *and which* he uses well.
(ix) There is the man I lent a five-pound note to.
(x) I like books whose pages are uncut.

In (vi) the mistake is a bad one; the antecedent of *who* is men, which is plural and so requires a plural verb. In (vii), *which* has no antecedent expressed, although the whole statement of the first sentence serves as such to the mind; the usage is, however, grammatically objectionable, and is easily avoided. (viii) has a bad solecism, or mistake in syntax: omit *and* or replace *which* by *them*. The locution *and which* is bad except in a case like (xi):—

(xi) The books which were lying on the table and which I was pleased to see are mine.

Here both the words *which* refer to *books*; and the two sentences, being equally adjuncts of *books* are rightly joined by *and*.

Who, Whom, Whose

In (ix) we have an example of the omitted relative, occasionally allowable, but often leading to awkward constructions. It is better to say precisely, "There is the man to whom I lent a five-pound note." The omission should only be made in simple cases in which it would be pedantic to avoid it, as in "Is this the man [whom] you met?" The nominative case of the relative is never omitted in good English prose.

Who, whom, whose are properly to be used of persons only, and *whose* in (x) is therefore objectionable, though such usage is becoming frequent. But no one would write "I like books *who* are uncut." For the same reason we ought to say "I like books the pages of which are uncut."

What, when relative, is equivalent to *that which*, and hence contains its own antecedent within itself: it must never be used when an antecedent is expressed, as in (xii):—

(xii) That was your book *what* I picked up [which].

As, when relative, has for its antecedent *the same, such, so many*, and similar phrases:

it must not be used as an alternative for *who* or *that*, though the latter is sometimes passed by good writers, wrongly, in exchange for *as*.

The mistake in (xiii) is very bad : that in (xiv) is pardonable :—

(xiii) Give me the book *as* I lent you yesterday [that].

(xiv) This is the same book *that* I lent you [as].

The use of *whom* after *than*, as in (xv), is not correct in grammar, because *than* is not a preposition, but the phrase *than whom* must now be accepted as good idiom ; to write the correct *than who* is impossible, and other constructions must be used if the error is to be evaded.

(xv) I met Mr. Jones, *than whom* there is no more delightful man.

[= I met Mr. Jones, and there is no more delightful man than he.]

Interrogative Pronouns

Interrogative pronouns are those which ask questions :—*who*, *which*, *what*. Their case sometimes presents difficulty, which arises from the normal inversion of the sentence. If the student remembers that " What did he say ? " = " He did say what ? " he will avoid the mistake in " *Who* did he see ? " For the interrogative pronoun is clearly the object, and *who* is only nominative. *Whom* is wrong in (xvi), however, because the interrogative is not there the object of *say*, but the complement of *am*, which must be nominative.

(xvi) *Whom* do you say I am ? [who ?]
[= You say I am *who ?*]

Indefinite Pronouns

The indefinite pronoun is one which stands in the place of some noun not defined, e.g. *one*, *some*, *any*, *nobody*, *somebody*, *nothing*, *each*, *either*, etc.

Photo : Gillman & Co., Oxford.

BODLEIAN LIBRARY, OXFORD UNIVERSITY,
One of the largest libraries in the world. It has over 500,000 printed volumes and 30,000 volumes of manuscripts.

(xvii) *One* is bound to take his chance.
Some are born great.

Pronouns are, of course, indispensable in our own or any language, but they must be used with care and exactitude ; there must be no mistake about the nouns for which they stand, or we get the ambiguities of examples (xviii)–(xx) :—

(xviii) John met a friend yesterday, and *he* told *him* that *his* father was dead.

(xix) The girl passed a flock of sheep, *who* was coming home from school.

(xx) I went for a ride on my bicycle in the rain : *it* was splendid.

Adjuncts of nouns or pronouns are spoken of as **Adjectives.** Thus an adjective may be defined as a word which qualifies or defines

a noun or pronoun, e.g. *the* man, *two* men *those* men, *red* men. Nouns, pronouns, and verbs, even adverbs and prepositions, may be used as adjectives on occasion : the *iron* box, *their* book, the *saving* grace, the *then* captain, the *under* dog, etc.

Adjectives have grammatically two uses—the attributive and the predicative :—

The *sad* man—Attributive.
The man is *sad*—Predicative.

There is now no distinction in form to mark these two distinct functions.

The different kinds of adjective are those of quality (*red, kind*) ; of quantity (*many, few*) ; of number (*two, third*) ; the demonstrative (*this, that, such*) ; the distributive (*each, neither, every*) ; the interrogative (*which ? what ?*) ; and the indefinite (*some, a*). Some of these adjectives are also pronouns ; but the distinction between the two uses is easy to understand ; when *this, such, some, each*, etc., are adjectives they are followed by the noun they belong to and cannot be replaced or emphasised by a noun :—*each* boy, *such* a boy, *some* good boys.

Comparison of Adjectives

Inflexions survive only in the plural forms of *this* and *that*, which are the only adjectives that agree with their nouns. *An* does not contain an inflexion : both *a* and *an* are merely modified forms of O.E. *an* = one. The form *an* is used before vowels or silent *h*, except when the vowel has a consonantal sound at the beginning : we write, *an* army—*an* uncle—*an* honour—*an* hotel, but *a* union —*a* ewe—*a* hospital—*a* one-armed man. It is a matter of euphony, not of grammatical form.

We recognise three degrees of any quality, to which correspond the three degrees of comparison in adjectives. We may speak of a thing as *small* (the positive degree) ; or, in comparison with another thing, as *smaller* (the comparative degree) ; or, in relation to all other things of the kind considered, as *smallest* (the superlative degree).

The comparative should be used when two things only are compared, and not the superlative as in the following examples :—

(i) He is the *smallest* of the two [smaller].
(ii) He is the finest of all other men I have seen. [Either omit *other*, which is really a comparative word ; *or* say " finer than " for " the finest of."]

On the other hand, (iii) is not strictly correct because *anyone* includes himself.

(iii) He is stronger than anyone [anyone else, *or* any other man].

The word *less* is the comparative of *little* and should not be used in reference to number, for which *fewer* is required, as in the following example.

(iv) There were *less* men in London than usual [fewer].

Double comparatives and superlatives are frequent in Shakespeare, but are not allowable in modern English. Thus, *worser* for *worse*, the comparative of *bad*, is a bad blunder.

" Good men and women " generally means that both the men and the women are good ; but it need not, and, indeed, should not : sometimes, in fact, it is absolutely necessary to repeat the adjective in order to be lucid. Consider, for example, the difference between (v) and (vi) :—

(v) I met the dressmaker and milliner [i.e. I met one person].
(vi) I met the dressmaker and the milliner [i.e. two different persons].

Similar ambiguity arises where two adjectives qualify the same noun. Thus, in " I observed the blue and yellow stars," it is implied that the particular stars observed were both blue and yellow : what ought to have been written is, " I observed the blue and the yellow stars," which means that I observed two groups of stars—one blue, the other yellow. Such mistakes as this are painfully frequent, and anyone who wishes to write good English should avoid them.

Principal and Subordinate Sentences

Phrases and sentences may be equivalent to adjectives in function, and are then spoken of as Adjective phrases or sentences. Thus, in the simple sentence " The book lying on the table belongs to me," the phrase " lying on the table " is an adjective phrase, acting as adjunct to the noun *book*. But in the sentence " The book which belongs to me is lying on the table," the adjunct of the word *book* is the sentence " which belongs to me."

The whole sentence just quoted is thus formed of two sentences, one of which is dependent on or **subordinate** to the other. Such a sentence is called a **complex sentence,** and it is usual to speak of the constituent sentences of a complex sentence as clauses. Of the two clauses in our example, that which contains the main statement is " The book is lying on the table " ; it forms what is called the **principal clause.** The words " which belongs to me " are clearly dependent on the word *book*, and form the subordinate—in this case, adjective—clause.

We may, therefore, analyse our complex sentence as follows :—

The book is lying on the table	Principal Clause.
Which belongs to me	Adjective Clause, qual. "book."

Adjective Clauses

Adjective clauses commence always with a relative pronoun, by means of which they are attached to the noun they belong to. In some cases the adjective clause cannot be removed from the complex sentence without destroying the purport of the statement; they restrict or define the meaning of a noun in some way that is necessary to the sense. Thus, in "The soldiers who have been wounded were brought back to England," the adjective clause, "who have been wounded," contains the gist of the statement that we desire to make. Omit it, and our statement is incorrect. Such an adjective clause is spoken of as a **restrictive** or **defining** clause. On the other hand an adjective clause may be merely an interesting or descriptive appendix to the principal clause, which itself contains the essence of the statement. For example, in "I am a student of astronomy, which is a fascinating science," the adjective clause, "which is a fascinating science," does not restrict or define the word, *astronomy*, to which it refers; it may be removed, and yet leave the essential fact unimpaired. Such an adjective clause may be classed as **descriptive** or **non-defining.** Having learned to distinguish an adjective clause, the student should then classify them into the two kinds here explained.

In the two examples quoted in the last paragraph the student will note with advantage the difference in punctuation. No comma separates the restrictive clause from its principal clause. On the other hand, the descriptive clause, which conveys something additional to the essential fact, is preceded by a comma.

When the antecedent of a relative pronoun is a person or persons, the proper relative is in all cases *who*; but for non-personal antecedents we have a choice between *which* and *that*. It is impossible to give an invariable rule for the appropriate choice between these two. Nevertheless, a careful writer will always use *which*, and never *that*, to introduce the descriptive type of clause; and he will always have a prejudice for *that* as the suitable relative for the restrictive kind. Thus he will not write, "I am a student of astronomy, that is a fascinating science"; and he will prefer "The book that belongs to me is on the table" to "the book which belongs . . ." Many instances occur, however, in which he will not be able to exercise this preference without pedantry. *That* is never employed, even in defining clauses, (i.) when the relative is governed by a preposition; (ii.) when it is widely separated from its antecedent or its verb; (iii.) when another *that* immediately precedes or follows it, as is shown in the following examples:

(i.) "The immense empire *over which* Attila had established his control then crumbled immediately, for it had no territorial basis and no established form of government."

(ii.) "It was a *mixture* of the Latin tongue with that of the Teutons *which* gave rise to the Romance languages, the languages, that is to say, of Spain, France and Italy."

(iii.) "As the seat of the Papacy, Rome became the capital of an administration greater even than *that which* the House of Cæsar had laboured to build."

In certain circumstances *that* may be used for *who* in defining clauses. We may do so when the antecedent is indefinite or exclusive or a superlative: e.g. *that* is preferable to *who* in the following examples :—

(i.) Who was it that spoke? [Indefinite antecedent, *it*.]

(ii.) You were the person that spoke. [Exclusive antecedent.]

(iii.) You are the worst scholar that I know. [Superlative antecedent.]

EXERCISES.—1. Analyse the following simple sentences :—

(*a*) The curfew tolls the knell of parting day.
(*b*) Sweet are the uses of adversity.
(*c*) Plain living and high thinking are no more.
(*d*) How sweet the moonlight sleeps upon this bank.
(*e*) Caught in the hunter's toils the stag died painfully.

2. Make sentences containing phrases used as adjuncts to the subject and to the verb respectively.

3. Mention, with examples, the different kinds of pronoun.

4. Write the usual plurals of :—cargo, dwarf, bureau, Lord Mayor, marquis, duchess, fez, criterion, erratum, coney, soliloquy.

5. Put suitable verbs as predicates to :—eaves, scissors, fish, tidings, phenomena, covey, the Council, the commons—in order to show which are singular and which plural.

6. Make sentences containing the following :—*which* as plural number and objective case; *that* as a relative pronoun in the objective case; *this* as pronoun; *whom* as interrogative pronoun; *as* as relative pronoun.

7. Correct, or justify :—

(*a*) He was the guilty one, not me.
(*b*) Both members resigned his seat.
(*c*) None of them were ready to go.
(*d*) The Duke, and a number of friends with him, was present.
(*e*) I, and John also, are ready to go.
(*f*) Whom do they think I am?

E. W. E.

Continued from page 272.

HISTORY:

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THE RISE OF THE PAPACY

WHILE the Frankish Government was acquiring that strength which, under Charlemagne, made it the predominant force in Western Europe, another and more perfect organisation was slowly developing within the old Roman dominions, an organisation with a far greater vitality than Charlemagne's empire; one destined, moreover, to have more lasting effects on the course of history. And it is to the growth of this organisation, to the growth of the Papacy, that we must next turn our attention.

We have already seen how under the rule of the Emperor Constantine Christianity became legal within the Empire (p. 144). By the Edict of Milan, 313, he guaranteed universal toleration in all matters of religion, ordaining that the rights, civil and religious, which Christians hitherto had been denied, should now be extended to them, and that persons dwelling within the Empire should be free each to follow whatever form of religion he thought fit to prefer.

The Council of Nicæa

But neither the Edict of Milan, nor the subsequent letter of Constantine commending to his subjects the tenets of the Christian faith, can be said to mark the death of paganism within the Empire. The old beliefs still lingered in many hearts and expired only by imperceptible gradations. But all the while the new beliefs gained steadily in strength.

In 325 there was held at Nicæa, under the auspices of the Emperor Constantine, a great ecclesiasical council to pronounce final judgment in the dispute (p. 205) which had arisen as a result of the views brought forward by Arius respecting the Trinity. This meeting—commonly called the Council of Nice—was the first General Council of the Church, and was—apart from the vital question of dogma which it settled—of great importance in the history of Christendom.

In the first place it established that union, destined later to be a serious source of friction between Church and State. Secondly, it showed that Christianity was a living force with a definite organisation. The Catholic Church, in fact, to all intents and purposes had already assumed the form which it still possesses. As yet, it is true, there was no mention of a Pope, or of any single head of the Church. But his day was not very distant; the See of Rome was already coming to be regarded as the centre of Western Christendom; and after Odoacer had overthrown the Western Empire (A.D. 476), the Bishops of Rome rapidly acquired an influence which ultimately proved greater than that of the line of rulers whose power the barbarian chieftain had brought to an end.

"Upon this Rock . . ."

The initial stages of the change which effected the substitution of a spiritual for a military dominion are not easy to follow, but there can be no doubt that the Bishops of Rome always enjoyed a certain eminence over other bishops, in that they derived, or professed to derive, their power from St. Peter whom Jesus Christ, apparently, specially singled out for the headship of the Apostles, when He declared, "And I say also unto thee, that thou art Peter, and upon this rock I will build My church; and the gates of hell shall not prevail against it. And I will give unto thee the keys of heaven: and whatsoever thou shalt bind on earth shall be bound in heaven; and whatsoever thou shalt loose on earth shall be loosed in heaven." *

Whether St. Peter ever visited Rome is a question open to historical doubt. Indeed, it is more than probable that he never did so. On the other hand, the belief that he did, and that he founded the Roman Church, is an undeniable fact; and this belief, since

* The Gospel according to St. Matthew, ch. xvi., 18, 19.

it was never doubted during the Middle Ages, served as a foundation upon which the Papal power could be firmly based.

When St. Peter died, his mysterious commission was, according to the legend, passed on to Linus, a native of Etruria, and then regularly transmitted to all succeeding incumbents.

The chronology of the early Roman Bishops is very obscure, and there is but little to relate of those who filled the chair prior to the accession of Leo the Great in 440. Up to that time there is nothing to show that the Pontiffs held a supreme position. They were not called Popes; nor were they temporal sovereigns; nor did they claim to exercise jurisdiction over kings and commonwealths. They were simply spiritual overseers, elected by the clergy and laity.

Leo, however, secured a great addition to his power when in 445 Valentine III., Emperor of the West, decreed that the Bishop of Rome, by virtue of his apostolic succession and of the past greatness of the Empire's old capital, should be the supreme head of the Church; that bishops throughout the West should accept his wishes as law; and that any provincial bishop refusing to obey a summons to Rome should be forced into submission by the local Imperial governor.

With the accession of Leo the Great (A.D. 440), therefore, the history of the Papacy may be said to begin.

The division of the Empire after the death of Constantine tended to make more and more pronounced the separation of the Western and Eastern Churches, which had already begun, and which resulted, not unnaturally, from difference of race, language, and tradition. But, at the time of Leo, the Greek and Roman Churches must still be regarded as belonging to one Christian community; the final and complete division did not occur until the ninth century. When, however, the Western Empire succumbed to the Goths, as happened soon after the death of Leo the Great, the power of the Roman Bishops increased in proportion to the diminution of Imperial authority.

During the years that Theodoric and his East Goths were masters of Italy, the people of Rome—and, for that matter, of Italy also—looked more and more to the Bishop of Rome as the defender of their liberties and as their natural leader. The Church, in fact, stood at this period as the one and only rock on the shifting sands of Italy's misfortunes. Conditions in Rome were deplorable. Its ancient greatness had passed away; its subsequent greatness, as the capital of Western Christendom, had hardly begun; and the poverty of the inhabitants harmonised with the melancholy ruins of Imperial dominion.

From a medal in the British Museum.

GREGORY THE GREAT,
who filled the Papal chair from 590–604, was responsible for the sending of St. Augustine as a missionary to England.

Now it so happened that at this time there rose to the headship of the Church a man who, although he never bore the Papal title, has come to be recognised as one of the most illustrious of all the Popes, and shares with Augustine, Ambrose, and Jerome the distinction of being one of the four great Latin "fathers."

Gregory the Great belonged by birth to a noble Roman family, and in 573, when about twenty-three years of age, was elected Prefect of Rome. The bent of his mind, however, was religious and ascetic, and as he grew older he began to feel that wealth and position were tending to make him worldly and arrogant. So he resigned his office and spent the whole of his fortune in founding monasteries. One of these monasteries he entered himself, and there, during the next few years, submitted to a discipline so severe and exacting that it utterly shattered his health, and would probably have brought his life to a premature end had he not been forced to relinquish it. At the express request of Pelagius II., the then Bishop of Rome, Gregory was attached to a mission sent to Constantinople to ask for the Emperor's assistance against the Lombards in Italy. In conducting those

negotiations he greatly distinguished himself, and on his return to Rome in 590 found himself elected the successor of Pelagius.

At first Gregory was reluctant to accept so onerous an office; but, when at length compelled to assume its duties, he administered the affairs of the Church with much enthusiasm and vigour, proving himself a great statesman as well as a good ecclesiastic. Further, he enjoyed a reputation as a writer, unrivalled throughout the Middle Ages; but this reputation can only be regarded as a striking commentary on the culture of those times, for Gregory's writings are puerile and illiterate in the extreme. In his *magnum opus*, for example, a book on the Prophet Job, he calmly warns his readers to be prepared for mistakes in grammar, since when writing on so inspiring a subject he could not bring himself to give careful attention to such matters as cases and tenses.

None the less, Gregory accomplished a very great work. It was he who sent St. Augustine to England to convert our Teutonic ancestors. It was he who reconciled the Arians of Italy and Spain to the Catholic Church. It is to him that we owe the Gregorian chant. Further, he settled the Roman liturgy, and by his eminent goodness, his simplicity of living, and tolerance, did more than any of his predecessors to enhance the sanctity and dignity of the office which he filled.

Papal Functions

Gregory strongly denounced any claim to universal rule as being distinctly anti-Christian. None the less, he sedulously accustomed all the sees of the West to pay particular regard to his own primacy. This primacy was enforced in each succeeding age with greater strictness, until at last the provincial bishops—that is to say, the bishops of the various provinces of what once had been the Western Empire—found their independent powers diminished to such an extent that even their election was not considered valid unless confirmed by the Bishop of Rome.

Boniface III., elected to the Papal chair in 607, was the first of the Bishops of Rome to use the name Pope as a special and distinctive title. The word is derived from the Latin *papa*, meaning father; and during the early years of the Christian Church was applied quite naturally to all bishops and even to priests. Boniface III., however, persuaded the Emperor of the East to confer it as a mark of distinction on himself and succeeding Bishops of Rome; and, though it was not until the time of Gregory VII., who died in 1085, that its use was forbidden to other prelates, and it became essentially the title of the supreme Pontiff of the Roman Church, the See of Rome, in consequence of Boniface's action, acquired a dignity and importance even greater than that with which Gregory had invested it. Even so, some ages had still to elapse before the Roman Bishops claimed jurisdiction not merely over other branches of the Church and over the minds and consciences of men, but over kings and magistracies in their official capacity.

In the days of Boniface III., it must be remembered, Rome formed a portion of the Eastern Empire, and it was on this account that Boniface was obliged to obtain the consent of the Emperor before he could assert the powers of a Universal Bishop. The claim which he put forward, however, was never acknowledged by the Eastern Church, although it was frequently pressed. This led to many angry disagreements, and finally to a complete rupture.

The Monastic System

The assumptions of Rome admittedly were productive of many harmful consequences to mankind when they began to tell upon the lives of individuals and the policy of States. But, like all other subtle influences, they were slow in their operation; and, at a time when the social and political life of Europe was in the melting pot, it cannot be doubted that the organised activities of Rome did an incalculable amount of good from a secular as well as from a purely religious point of view. During the early Christian centuries the ecclesiastics of the Western world were for the most part devout and conscientious men. They inherited, moreover, not a little of the ancient civilisation and culture, and so formed an invaluable counterpoise to the rugged violence of the Goths and Vandals.

Repeated invasions by uncivilised—or, at the best, only semi-civilised—tribes had ruined the cities of Italy, Gaul, and Spain; and at the same time had driven large numbers of peasants into those very towns, as places offering some slight degree of protection against the barbarian hordes who roamed at will over the open country. In consequence, not only were commerce and the arts impaired in the great cities, but agriculture languished in the fields. Population decreased with alarming rapidity; pastures returned to the condition of

primeval forest and marsh; whilst the few cultivators of the soil who still remained, being now subjected by warriors of alien race who understood neither the language nor feelings of Romanised communities, sank to the level of mere serfs, and lost interest in doing more than the barest necessities of the hour required.

During these years of general disruption and decline, it was the Church that saved civilisation from utter disintegration—the Church and, in particular, the ecclesiastical brotherhoods. The latter cherished the memory of a better state, and preserved some tincture of learning and intellect; whilst such was their influence that even the rude barbarian invaders respected their lives and property. The monasteries, in fact, in those early ages were really so many oases in the desert of barbarism; and the monks wisely devoted their energies not merely to propagating the dogmas of their faith, but also to drawing forth all the capabilities of the land consecrated to their use.

The monastic system, which had existed in the East in its worst and most extravagant form since a very early age in the history of Christianity, rapidly gained ground in the West during the sixth century. Its introduction into this part of Europe is commonly but erroneously attributed to St. Benedict. St. Benedict was not the pioneer of monasticism in Western Europe, though it is true that most of the early monasteries were founded on the rules which he had drawn up, and which proved a constitution in every respect admirable for such institutions.

St. Benedict regarded idleness as the greatest enemy of the soul; and while enforcing celibacy and forbidding the amassing of personal wealth—two rules obviously essential to monastic life—he urged upon his followers to combine with prayer and meditation healthful manual occupations. "No person," he declared, "is ever more usefully employed than when working with his hands, or following the plough, so as to provide food for the use of man." This rule, directed against that excess of asceticism which had been the ruin of the monastic system in the East, enabled monks to lead normal, rational lives; and their ordered toil was not merely a blessing in itself, but served as a salutary example which the barbarian conquerors at length began to follow.

Again, the lands of the monks were places

From the fresco by William Dyer, R.A., in the House of Lords.

THE BAPTISM OF ETHELBERT, KING OF KENT, BY ST. AUGUSTINE IN 597.

of sanctuary; and even the rude barbarian invaders respected their privileges. The monasteries, therefore, were able to afford

From the painting by Ambrogio Borgognone. The property of Henry Hucks Gibbs, Esq.

ST. AUGUSTINE WITH A DONOR.

A panel which probably formed one wing of an altar-piece; the corresponding wing, St. Peter with a Donatrix, is in the Louvre.

refuge and safety to thousands of hapless people who otherwise would have been wiped out or rendered destitute by the hardship of war. And by protecting the weak against the strong the monks did a really great work; but in preserving at any rate the shadow of learning in an age of great ignorance they did a work even greater. The monks—and only a small minority of them—possessed any real intellectual culture; they alone were conversant with the principles of law, public morality, and historical policy—matters of which the laity, not excepting men of the highest rank, were almost wholly ignorant.

During the Dark Ages, the literature and art of ancient Greece and Rome passed almost entirely into the hands of churchmen, who formed a vast community, scattered over Europe, but bound together by frequent intercommunication and identity of interest.

In the course of the seventh century, however, many of these virtues were lost. The monasteries became fenced about with privileges and immunities, granted by kings and powerful feudal nobles who reverenced the ecclesiastics and recognised in them an intelligence greater than their own. Thus the monks became lazy and sensual; and their overgrown establishments proved a curse rather than a blessing to Europe.

The Mahometan Menace

The Church, too, became self-seeking and arrogant. Ecclesiastics, individually, fell into a state of ignorance little better than that of Teutonic invaders who poured over the Roman Empire in its decline. The increasing power of the Roman Pontiff sapped the independence and self-respect of the minor bishops. Idolatry gathered force.

Superstition, and consequently priestcraft, arose in the Catholic Church as the violence and rapacity of feudal chiefs were rampant. Learning was made subservient to the avarice and ambition of the priesthood; the sacerdotal office, from its lowest to its highest grade, became an object of purchase and sale. The morals of the clergy, despite a few high and noble examples, were a notorious scandal.

Christendom became split up into a multitude of sects, which disputed with one another on a hundred subtleties of doctrine, such as no one could make clear to his opponent, or even to himself.

Christianity seemed doomed to extinction, and a large portion of the world was prepared for the advent of a new religion. Then that new religion came—the religion of Mahomet, issuing fresh from the desert of Arabia and armed with those powers which the Christian Church had temporarily lost: simplicity and sincerity, courage and zeal. J. A. B.

Continued from page 288.

SCIENCES:

Contributors:—ANTHROPOLOGY AND ETHNOLOGY (Sir H. H. Johnston, G.C.M.G., K.C.B.). ASTRONOMY (Arthur R. Hinks, M.A., F.R.S.). BOTANY (E. W. Edmunds, M.A., B.Sc.[Lond.]). CHEMISTRY (E. H. Tripp, Ph.D.). ELECTRICITY AND MAGNETISM (L. M. Parsons, M.Sc., D.I.C., F.G.S.). GEOLOGY AND MINERALOGY (Arthur Holmes, D.Sc. [Lond.], A.R.C.S., D.I.C., F.G.S.). PHYSIOLOGY (Sir Malcolm Morris, K.C.V.O., and D. W. Carmalt-Jones, M.A., M.D.[Oxon.]). SOUND, LIGHT, AND HEAT (E. W. Edmunds, M.A. B.Sc. [Lond.]). ZOOLOGY (E. A. Bryant and Ashley G. Brown, F.Z.S.).

CHEMISTRY.—VI

Hydrogen.—Early in the sixteenth century there lived in Central Europe a remarkable man who taught that the object of chemistry was not to make gold but to prepare medicines. His full name was Philippus Aureolus Paracelsus Theophrastus Bombastus, but he is known to history as plain Paracelsus. Among other discoveries he is said to have been the first to prepare hydrogen, but it was left to the famous English chemist, the Hon. Henry Cavendish, to isolate the gas in a fairly pure state and to investigate its properties (1766).

Cavendish showed how it could be made from dilute sulphuric acid and zinc, and this is the laboratory method usually employed to-day.

Experiment XVIII.—*The action of sulphuric acid upon zinc.*

Some sulphuric acid is poured on to some granulated zinc in a test-tube: there is no action. The strong acid is poured off and dilute acid (about 1 of acid to 4 or 5 of water) is substituted. A vigorous effervescence takes place, and if a light be applied to the mouth of the tube a shrill explosion is heard. After a time, when the air in the tube has been displaced by the gas, the issuing hydrogen will catch fire, without any explosion, and burn with a pale bluish flame somewhat tinged with yellow.

Iron acts in a similar manner, but in this case the gas obtained is very impure owing to the carbon present in the iron. Both zinc and iron dissolve completely in the acid, but certain impurities, notably carbon, present will remain undissolved. Hydrochloric acid, either concentrated or dilute, may be substituted for the sulphuric acid. Magnesium rapidly dissolves even in very dilute acid, giving the same gas and a colourless liquid.

Experiment XIX.—*To prepare hydrogen from dilute sulphuric acid and zinc.*

The apparatus consists of a flask of about 1,250 c.c. capacity provided with a well-fitting cork bored in two places. Through one hole passes a thistle-funnel which reaches down nearly to the bottom of the flask, and through the other a long delivery tube bent as shown in the sketch: Passing through the cork in the flask the tube dips into a pneumatic trough containing water and a beehive-shelf. The method of collection is the same as that used for oxygen. The bottom of the flask is covered with granulated zinc, which is introduced in a slanting direction, and the cork is then inserted.

The dilute sulphuric acid is then poured through the funnel, and if the action is too slow, a few drops of copper sulphate solution may be added. The first bubbles which emerge from the water in the trough will consist of air; these will be followed

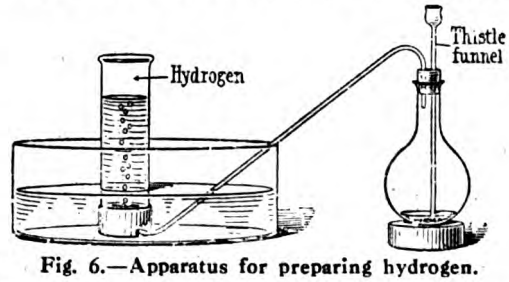


Fig. 6.—Apparatus for preparing hydrogen.

by a mixture of air and hydrogen, and then by hydrogen alone. Samples of the issuing gas must be collected in a test-tube and tested with a flame. Only when explosions have ceased and the gas ignites with a very faint sound is it safe to start collecting in the gas jars.

Hydrogen is colourless and invisible, and, if it be pure, without smell or taste. It is only very slightly soluble in water, even less soluble than oxygen. 1 litre of water at 15° C. dissolves 29 c.c. of oxygen, but only 19 c.c. of hydrogen.

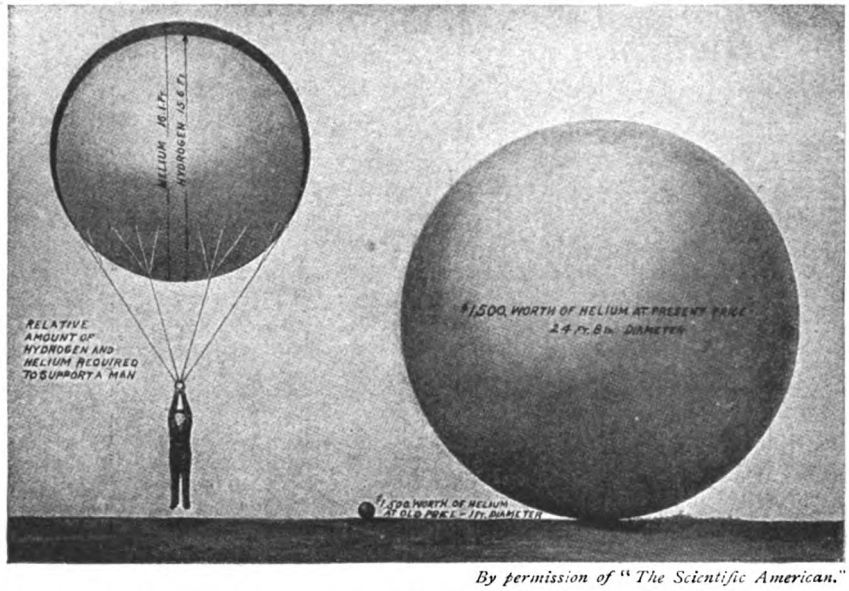
The following experiments should be performed:

(i.) A light is applied to the mouth of the jar: the gas burns with a slightly yellow flame, the yellow colour being due to the presence of sodium in the glass and in the dust of the air. A mist or dew forms on the inside of the gas-jar.

(ii.) To find out if the gas is lighter or heavier than air, the glass plate is removed from a jar, and after waiting about 10 seconds a light is brought near its mouth. The hydrogen has disappeared. It must, therefore, be lighter than air.

It is not only lighter than air, but is the *lightest substance known*, being 14 times lighter than nitrogen, 14·4 times lighter than air, 16 times lighter than oxgyen, and no less than 240,000 times lighter than the noble metal platinum. 1 litre of hydrogen weighs approximately 0·089 gram, or 1 gram of it occupies 11$\frac{1}{9}$ litres.

The extreme lightness of hydrogen can be illustrated in a variety of ways. It may be poured *upwards* from one jar to another. (The jars should be placed so that they make an angle of about 135° C. with one another.) Soap bubbles, made from a mixture of sodium oleate, water and glycerin, ascend very rapidly when blown with hydrogen. For this purpose the latter must be freed from acid spray by passing it through water or through a long tube containing cotton wool. A collodion balloon filled with it also rises rapidly. A gas jar may be collected by "upward displacement."



By permission of "The Scientific American."

DIAGRAM ILLUSTRATING THE LIFTING POWER OF HELIUM.

This gas is likely soon to take the place of hydrogen for filling airships. As also is shown above, the cost of manufacture has been greatly reduced since 1914.

By experiment, also, the student should ascertain:

(*a*) Whether hydrogen supports combustion. A jar is inverted and a stout, lighted taper inserted. The flame is extinguished, although the gas itself burns at the mouth of the jar.

(*b*) What becomes of the zinc which dissolves in the acid? If sufficient acid was used the metal will have completely disappeared, leaving only a little impurity, chiefly carbon and lead, undissolved. We know that matter is indestructible, therefore the zinc will be present in the liquid, but in a new form.

The liquid is, therefore, passed through a filter and then partially evaporated by boiling. On standing, beautiful prism-shaped crystals will be deposited, which on account of their colour and glassy lustre were called "White Vitriol": they are now known as zinc sulphate, a name which connotes the fact that they contain zinc.

Uses.—Hydrogen, as already stated, is used for making the oxy-hydrogen flame which is employed for melting and welding metals, for working fused quartz, for making laboratory utensils and quartz mercury lamps. It finds further application in the manufacture of tungsten filament lamps, for hardening fats used in margarine manufacture, and for the synthetic production of ammonia. Lastly, hydrogen is much used for filling balloons and dirigible airships; 1 cubic metre of it has a lifting capacity of 1 kilogram.

The inflammability of hydrogen is a serious drawback to its use for this purpose, and it is therefore proposed to employ the next lightest gas, *helium*, instead. Helium is nearly twice as heavy as hydrogen, but it is not combustible. It is always present in the air in exceedingly small amounts, but somewhat larger quantities are found in certain mineral springs, and it is from this source that the gas has been isolated on an industrial scale for use in airships. Up to June, 1917, not more than 100 cubic feet of helium had been isolated as a pure gas, and its selling price was about £350 per cubic foot; at the time of signing the armistice the first shipment of 147,000 cubic feet of 93 % purity was ready for use. Plants are now under construction in the United States to give at least 50,000 cubic feet per day, at an estimated cost of not more than 1d. per cubic foot.

Experiments for weighing of hydrogen, either directly or by difference, are unsuitable for beginners, because owing to the extreme lightness of the gas, the inevitable errors of experiment and weighing become greatly magnified in the final results. It is, however, possible to measure the volume of gas obtained from a known weight of metal and dilute acid.

It must be mentioned here that the volume of a gas depends upon the temperature and upon the pressure under which it is measured. The former is obtained by reading the thermometer in the neighbourhood of the apparatus, and the pressure of the gas is usually made equal to that of the external air, so that its absolute value can be directly found by reading the height of the barometer.

Experiment XX.—*To find the volume of hydrogen evolved by the action of dilute sulphuric acid upon 1 gram of zinc.*

A large flask, or Winchester bottle, measuring 2 litres or more, is fitted with a rubber bung through which pass two tubes: one communicates with a small flask in which the reaction between metal and acid takes place, and the other is joined by rubber tubing to a glass tube which dips into a gas jar or measuring cylinder. A spring clip is fixed on the rubber connection so that the tube can be opened or closed at will. The flask is about ¾ filled with water, the bung is firmly inserted by a screwing

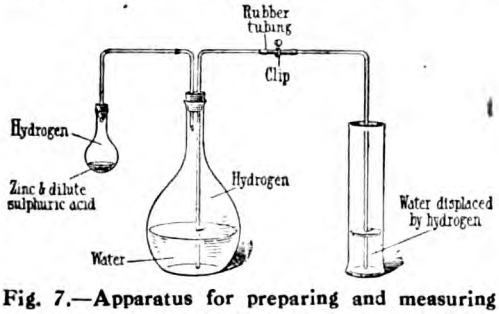


Fig. 7.—Apparatus for preparing and measuring hydrogen.

movement and the long tube is filled with water by sucking the air out at the lower end, and the clip is closed.

About 25 c.c. of dilute sulphuric acid and the merest trace o copper sulphate solution are put in the small flask, and then the weighed piece of zinc (about 0·5–0·75 g.) is dropped in and the flask quickly attached to its cork. Directly the evolution of hydrogen begins, the clip is unloosened, so that the water displaced from the large flask is driven into the collecting vessel. When all action has ceased, the gas is brought to atmospheric pressure by raising or lowering it until the level of the remaining water is the same as that in the cylinder.

The volume of water displaced is then either read directly on the measuring cylinder, or, if a gas jar has been used, the water is poured from it into a measuring vessel. The experimental figures may be entered thus*:

Weight of zinc taken = 0·45 g. Temperature 15° C.
Volume of hydrogen liberated
= 169 c.c. Barometer 756 mm.

Since 0·45 g. zinc set free 169 c.c. of hydrogen.

$$\therefore \quad 1 \text{ g. } \text{„ sets „ } \frac{169}{0{\cdot}45} \text{ „ „}$$
$$= 375 \text{ c.c.}$$

The experiment should be repeated with other metals, e.g. iron and magnesium, and with hydrochloric acid, as well as dilute sulphuric acid. The strength of acid most suitable should be ascertained by preliminary trial in a test-tube.

Under ordinary laboratory conditions: 1 gram of zinc liberates about 370 c.c. of hydrogen; a gram of magnesium 1000 c.c., and a gram of iron 425 c.c.; and the same volumes are obtained whichever acid (but not nitric acid) be used. Aluminium in hydrochloric acid (1 : 1) gives approximately 1300 c.c. of gas, and 1 gram of tin yields 200 c.c. In the former case, heat is necessary to start the action; in the latter, the acid must be kept heated the whole time.

In all cases where heat is applied, or evolved, the apparatus must be allowed to cool at the end of the experiment, with the end of the delivery tube below the level of the water in the collecting vessel. In this way the excess of water which has been driven over by the expansion due to heat is caused to flow back into the large flask. E. H. T.

* Since the temperature and pressure of the air are constantly varying, it is usual to calculate what the volume would be at a standard temperature and pressure, viz. 0° C. and 760 mm. of mercury. In this way it is possible to compare results obtained under different experimental conditions. The method of calculation will be explained in a subsequent lesson. (*See* HEAT, p. 340.)

HEAT.—V

24. Expansion when Pressure is not Constant.—WE must now apply a little algebra to the consideration of the laws of Charles and Boyle.

Let V_t stand for the volume of a gas at t°, V_0 for its volume at 0°, and α for its coefficient of expansion.

Then, $V_t = V_0 (1 + \alpha t)$.

For, if the gas be heated from 0° to t°, the expansion will be $\alpha V_0 t$; so that the volume after expansion will be $V_0 + \alpha V_0 t = V_0 (1 + \alpha t)$.

This formula, which, of course, applies to all cases of expansion, and should be memorised, may be written thus:

$$\frac{V_t}{V_0} = 1 + \alpha t.$$

In the case of gases, $\alpha = \frac{1}{273}$

$$\therefore \frac{V_t}{V_0} = 1 + \frac{1}{273} t = \frac{273 + t}{273} = \frac{T_t}{T_0}, \text{ where T =}$$

absolute temperature.

Hence the Law of Charles may be expressed in other words thus: *the volumes of gases under constant pressure are proportional to their absolute temperatures*, or $\frac{V}{T} = \text{constant}$.

But, by Boyle's Law, P V also = constant.

From this, it can be established algebraically that $\frac{P V}{T} = \text{constant}$.

EXAMPLE.—250 c.c. of air at 0°, and under a pressure of 750 mm., are heated to 91° while the pressure changes to 900 mm. What will be the new volume?

$$\text{Since } \frac{P V}{T} = \text{constant}, \frac{750 \times 250}{273} = \frac{900 \times V}{364}$$

$$\text{whence, } V = \frac{750 \times 250 \times 364}{273 \times 900} = 277{\cdot}8 \text{ c.c.}$$

This example might be worked without the formula, as follows:—

Suppose first that the pressure remains constant, and that we find the change of volume due to the heat alone.

250 c.c. at 0° expand $\frac{1}{273} \times 250 \times 91$ when heated to 91°.

$$\therefore \text{ vol. at } 91° = 250 + \frac{250}{3} = 333\tfrac{1}{3} \text{ c.c.}$$

Now, correct this volume for change of pressure.

At a pressure of 750 mm. the volume is $333\frac{1}{3}$ c.c.
At a pressure of 1 mm. the volume would be $333\frac{1}{3} \times 750$ c.c.
∴ At a pressure of 900 mm. the volume would be

$$= \frac{1000 \times 750}{3 \times 900} \text{ c.c.}$$
$$= 277{\cdot}8 \text{ c.c.}$$

This is the volume at 91° and 900 mm., as previously obtained.

In all scientific measurements involving gases, the experimenter must be prepared to make changes similar to the above. For, in order to make one measurement comparable with another, it is clear that the temperature and pressure must be the same in the two cases. They are generally "reduced" to the standard temperature of 0° and the standard pressure of 760 mm.

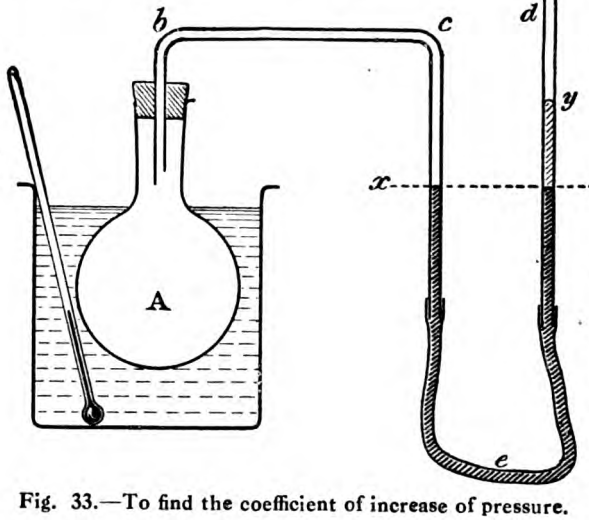


Fig. 33.—To find the coefficient of increase of pressure.

EXAMPLE.—A certain volume of gas was measured at 15° and 745 mm., and found to be 266 c.c. Reduce this volume to standard temperature and pressure.

Since $\frac{PV}{T}$ = constant, $\frac{745 \times 266}{288} = \frac{760 \times V}{273}$

$$\therefore V = \frac{745 \times 266 \times 273}{288 \times 760} = 247{\cdot}2 \text{ c.c.}$$

The equation, $\frac{PV}{T}$ = constant, suggests to us that, if V is kept unchanged, P will increase or diminish in the same ratio as T. In other words, if a gas is heated under such conditions that it cannot expand, the pressure will increase $\frac{1}{273}$ of its value at 0° for every degree it is heated.

This important fact can be demonstrated experimentally in the following manner:—

A dry flask (A, Fig. 33), about 250-300 c.c., is fitted with a cork and a delivery tube, twice bent at right angles at *b* and *c*, and connected with the long straight tube *d* by a long piece of rubber tubing *e*.

The flask is first placed in melting ice; mercury is poured into *d* till it reaches a convenient level; and the cork is then placed in the flask. By slightly raising or lowering *d*, the tube may be so adjusted that the mercury stands at the same level *x* on both sides of the rubber connection. The air in A will then be at a temperature of 0° and at the pressure of the atmosphere, which should now be read from a barometer.

Mark the position of *x* on the tube *c* with a piece of gummed paper. Then place the flask into a beaker of water at, say, 10°. The expanding air will of course, force the mercury down the tube *c*; but it can be forced back to the level *x* again by raising *d*: when this is done, we have the air occupying the same volume as before, but the mercury in *d* will be at a higher level than in *c*. Measure this distance very carefully; it will give us the increased pressure produced by the rise of temperature in A. Repeat this operation at several intervals of 10°, by heating the water in the beaker and adjusting the mercury to *x*, as before.

As an example—At 0°: atmospheric pressure, 750 mm.
Heated to 10°: rise in level, *x'y* = 27 mm.
Hence, increase on 750 mm. for 10° = 27 mm.
∴ increase on 1 mm. for 1° = $\frac{27}{750 \times 10}$ mm. = 0·0036.
∴ coefficient of increase of pressure = 0·0036 = $\frac{1}{273}$ approx.

25. Air-Thermometer.—The regular expansion of air through a wide range of temperature suggests at once the use of air as a suitable thermometric substance; and the ease and accuracy with which the measurement described in our last experiment can be made points out the practical method of its use.

Moreover, it can be used for high temperatures, because the measuring part of the apparatus need not be included in the hot place, and the flask A can be made of refractory material, such as platinum or porcelain while the cork can be done away with if the tube *b c* is made continuous with the neck of the flask and of the same material. Such an apparatus would be a *constant-volume air-thermometer.*

EXAMPLE.—Suppose the levels *x*, *x'*, to be adjusted at a known temperature and pressure; e.g. 12° and 722 mm. After surrounding A with the unknown temperature, *y* is found to be 243 mm. above *x*. What is the unknown temperature?

The volume being constant, the Pressure is proportional to the Absolute Temperature.
Hence, 722 : 285° :: 722 + 243 : T.
∴ $\frac{285 \times 965}{722}$ = T.
∴ T = 381°.
∴ temperature centigrade = 381° − 273° = 108°.

The tube used in the experiment of § 22 (*see* Fig. 32, p. 277) could be arranged as a *constant-pressure air-thermometer.* If the present apparatus were so used, it would be necessary to know the volume of the flask, and also to have the tube graduated into divisions, the volume of which was accurately

known. In addition, we should have to adjust *d* each time, so that the level in both tubes was the same, and the volume therefore measured in each case at the pressure of the atmosphere. The slight expansion of the flask would also have to be allowed for.

EXAMPLE.—Using the flask and delivery tube figured in Fig. 33, suppose the flask heated while the arm *c* is open. While the flask is hot, let the open tube be closed by means of a clip. Place A in melting ice, and open the clip under water. Suppose 170 c.c. of water run in, and the total volume of the flask and tube to be 300 c.c. Find the temperature of the flask originally.

130 c.c. of air are left in the flask. These 130 c.c. at 0° filled the flask at $x°$ and expanded 170 c.c.

Now, $\frac{1}{273} \times 130$ c.c. = expansion for 1°.

$\therefore$ 170 c.c. = expansion for $\frac{273 \times 170°}{130}$

$= 357°$.

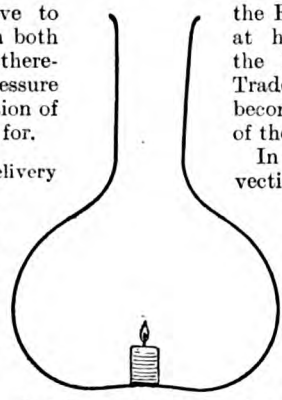


Fig. 34*a*.—Candle burning without ventilation.

26. Convection in Gases.—If the air at a certain spot is heated—as in the neighbourhood of a fire, for example—it expands and consequently becomes less dense or lighter than the cooler air surrounding it. As a result of this lightness, it tends to rise and thus to diminish the pressure at the heated spot. The result of this is that the cooler air flows towards the spot in order to equalise the pressure. Thus the air is set into movement by this local heating; the moving streams of air are called *Convection Currents*.

A *wind* is a convection current in the atmosphere, set up by unequal heating on the earth's surface.

A *sea-breeze* is a good example, resulting from the fact that the air above the land becomes hotter during the day than that over the sea.

The *Trade Winds* similarly arise from the fact that the equatorial air tends to rise and spread out towards the poles in the upper atmosphere, thus diminishing the pressure around the Equator. The air in the polar regions, at higher pressure, is thus drawn towards the Equator, and forms the prevalent Trade Winds. The northerly Trade Wind becomes north-easterly owing to the effect of the earth's rotation.

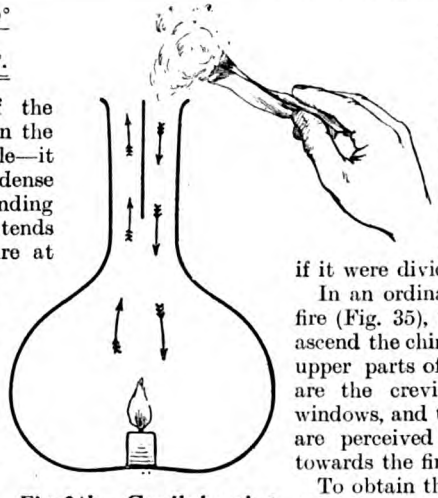


Fig. 34*b*.—Candle burning with ventilation.

In everyday life we take advantage of convection in our systems of *ventilation*. There can be no ventilation if an inlet for cooler air at a higher pressure is not provided. The need for this inlet can be simply illustrated by burning a small candle at the bottom of a flask (Fig. 34 *a*): it soon begins to flicker and go out. If, however, the neck of the flask be divided by a strip of cardboard (Fig. 34 *b*), and a draught created, the candle will continue to burn brightly, because we have now established an inlet for fresh air.

Even with a wide-mouthed jar, this simple device is a valuable aid. In a chimney with a fire at its base, we recognise that convection is not effective when it begins to smoke: sometimes the chimney makes its own down-draught, as if it were divided at the top.

In an ordinary room, heated by a fire (Fig. 35), the heated air tends to ascend the chimney and to rise to the upper parts of the room; the inlets are the crevices of the doors and windows, and the convection-currents are perceived as draughts, moving towards the fire.

To obtain the fresh air without the discomfort of a draught is the real problem of ventilation, and it cannot be said to have been solved—for large buildings, at least; a church

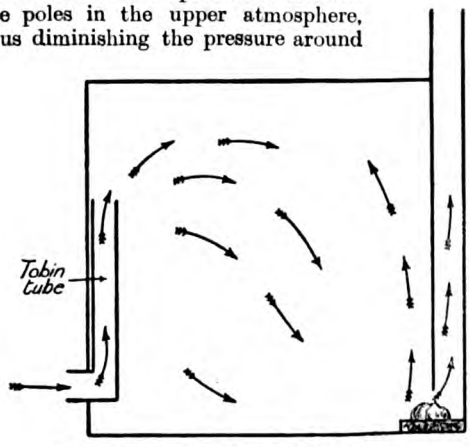


Fig. 35.—A Problem of Ventilation.

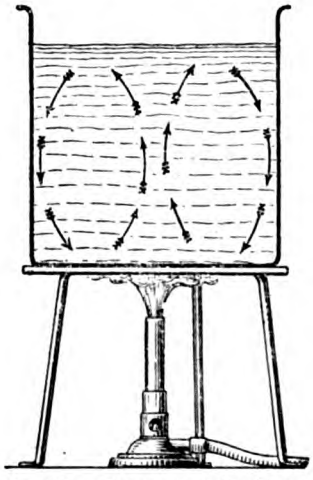


Fig. 36.—Convection in Liquids.

that is neither "stuffy" nor draughty probably does not exist!

The use of Tobin's tube (Fig. 35) has had fair results in schools, especially when it is placed so that the entering air is warmed, as it may be when the tube is taken through the chimney. But the matter is again complicated by the difficulty of regulating the source of the entrant air.

27. Convection in Liquids.—A similar process of convection goes on in liquids. When a vessel of water is heated from below, convection currents are set up, which may be made visible by sprinkling a little bran or fine sawdust in the water; the currents carry the light bran along with them (Fig. 36). If a test-tube of water be heated from below, it very soon becomes too hot to hold, if held near the top; on the other hand, the water may be boiled at the top, and the tube cause no discomfort if held at the bottom (Fig. 37). This latter fact shows incidentally that water is a bad conductor of heat, although heat is carried through it quickly by convection. Hence we always heat water from below.

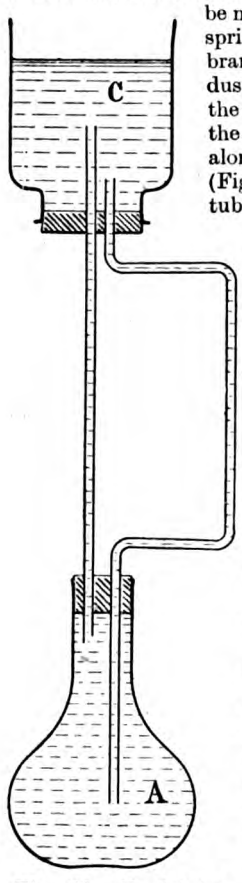


Fig. 38.—Explaining how heated water rises.

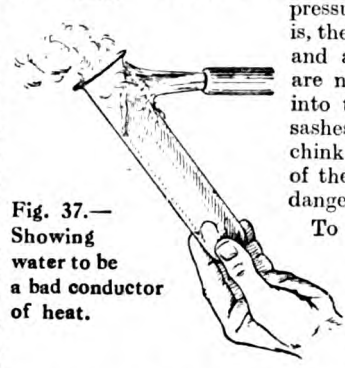


Fig. 37.—Showing water to be a bad conductor of heat.

Convection currents are also set up by cooling the surface of a liquid. This may be shown by dropping a lump of ice in a vessel of warm water: the course of the currents can be indicated as before with bran or sawdust.

Hot-water apparatus for warming buildings operates on the principle of convection. The whole system of pipes is filled from a cistern at the highest point of the building, and the water is heated in a boiler at the basement.

The hot water rises, by convection, to the upper rooms; it is cooled in circulating through the pipes and radiators, and returns to the boiler, as is shown in diagrammatic form in Fig. 39. The process is thus maintained by convection, and is most successful when the upper limit of the system is high, so that the water may be thoroughly cooled in its passage.

An apparatus for illustrating the behaviour of water in such a closed circuit is suggested in Fig. 38. The flask, A, corresponds to the boiler; C, a bottle with its bottom removed, is the cistern, and if coloured water is poured into this after the rest of the apparatus has been filled with uncoloured water the course of the currents can be easily followed.

Domestic Ventilation.—Where a room is heated by a fire in an open grate, the chimney provides in itself an efficient ventilator. The column of air in the chimney being hot is less heavy than an equal column of air outside; the pressure at the bottom is, in consequence, less than the pressure outside. The air in the room is, therefore, drawn through the grate, and ascends the chimney. If there are no proper inlets, air is dragged into the room between the window-sashes, under the doors, and other chinks and openings, and the inmates of the room feel the disagreeable and dangerous sensation of draught.

To avoid this, air should be made to enter, not horizontally or through gratings in the floor, but vertically. The opening should be high enough to allow the entering air to mix gradually with the upper section of the atmosphere of the room. The occupants will then feel no disagreeable effects and will not run the risk of catching colds to which they would be liable without such precautions.

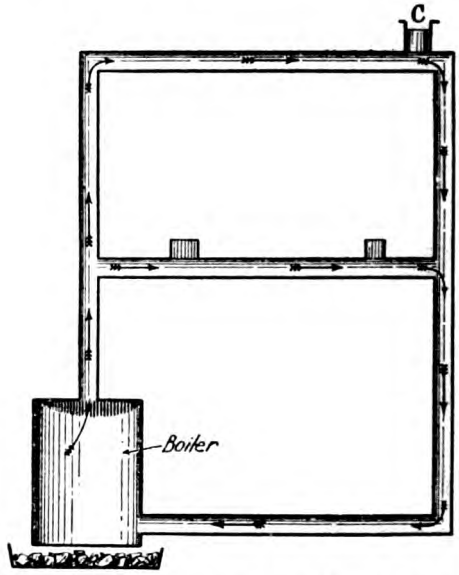


Fig. 39.—Illustrating the principle of a central heating apparatus.

Many devices have been invented to provide these openings. Hollow perforated air-bricks are sometimes built into the wall. Another plan is to set up a kind of makeshift Tobin tube. This is simply placing vertically a frame of wood in front of the lower sash when the window is opened.

E. W. E.

ZOOLOGY.—VI

THE rodents or gnawing animals form one of the most numerous and widespread of mammals. The number of species runs into thousands, the number of individuals to hosts beyond counting. We find in the group marked diversity of form, habitat, size, degree of intelligence, method of living, but all the vast order has one feature in common—the teeth.

Seek where we may throughout all the multitudinous species of rodents, we find an invariable characteristic peculiarity, that each and every member of the order is armed with a unique pair of chisel-shaped teeth in upper and lower jaws, that the canine teeth are absent, and that there occurs a wide gap between the incisors and the molars, which latter may be as few as two in each jaw, never more than six.

Rodent Characteristics

The evolution of the rodent dentition is as notable a triumph as the shedding by the horse of his surplus toes in favour of hoofs, or the bird's exchange of arms and fingers for wings and scales for feathers.

There seems to-day a sharp cleavage between the gnawers and the rest of warm-blooded quadrupeds, yet the singular functionless little false incisors lying at the back of the true incisors of the hare and rabbit remind us that the present order once earned its living by other means of biting. The little pair of false incisors in the upper jaw of hare and rabbit to-day are useless; they are vestiges of teeth which ancient rodents must have employed and gradually found of decreasing purpose, with the result that the great strong gnawing teeth in front have been made to bear full responsibility, and have risen to paramount consequence as the result of the tax imposed upon them. By the aid of those wonderful ivory chisels the rodents have gnawed their way into almost every habitable part of the globe. The external face of the tooth consists of hard fine enamel; the posterior surface of soft ivory, which, as the tooth is plied against hard, tough material, constantly wears down and is as constantly renewed, leaving the edge of the tooth ever sharp and keen.

As nature abhors a vacuum, so she declines to have any of her domains divorced from life. The rodents have succeeded enormously because they developed along lines which permitted them to fill gaps in the economy of creation.

They claim three elements for their life-scheme: earth, water, air. They are the princes of the underworld, for nowhere do we find more accomplished miners than among the gnawers. The squirrels are the mammalian monarchs of the trees, though they have relatives among the ground squirrels which climb no trees. We include three families of squirrels in the list of what we call flying animals. Of course, there are no true flying mammals save the bats.

The so-styled flying squirrels lost their way to true flight when they had achieved a marvellously successful parachute. This is a membrane extending along the sides which spreads out taut as the little animal takes its leap from branch to branch or from tree to tree.

Under the ground, up the trees, skimming the air the rodents have their representatives among the aquatic animals. Water is the sanctuary of the capybara; it is the highway of the coypu, which showmen turn to profit in exhibitions, displaying this animal as "the giant rat." The beaver, again, finds water indispensable to existence. Prairie and pasture land, steppe and desert, high hills and towering mountains, are among the territorial possessions of the rodents, and as every farmer knows to his cost, cultivated fields are ravaged by hares and rabbits to such an extent, even in England, as at times to make successful agriculture hopeless.

One of the serious facts of life is this question of the abounding fecundity of the rodents. The progeny of one pair of rabbits, were they all to come to maturity, would in three years fill all the tube railways of London.

Omnivorous Rats

Moreover, rodents carry disease to human beings. They alone are responsible for the dissemination of plague. Every parasite has its parasite, and that of the rat is a flea which carries the plague bacillus.

Rodents are mainly vegetarian, but the rat is omnivorous. It can tunnel the stoutest timber; it has been known to gnaw off live birds' legs, to bite through the soles of elephants' feet and cause the death of the animals, to bite to death sleeping infants, and attack invalids and old people as they lay in their beds. It is the most wily and astute of animals, appallingly prolific, bold, daring, and wily beyond comparison.

Rabbits, of which only a few couple were introduced originally into Australia, have become the curse of that sunny continent.

They eat the fodder from the sheep and cattle, and when drought comes and parches the unirrigated land, they close in from all quarters upon the irrigated farms themselves. It is in vain that the farms are fenced with wire. The famishing rabbits crowd in from all quarters in such unimaginable hosts that they crush down and rise upon tier after tier of the bodies of those already arrived at the wire.

So much for the relations between man and the rodents as they exist in scenes where the ancestors of these animals were the ancient occupants, or in areas to which, by carelessness or ignorance, he has carried them to his own undoing.

Food Hoarding

In the wilds to which civilisation has not yet penetrated, these creatures afford profoundly interesting studies. They are smooth-brained, as we have seen, yet if they do not remember yesterday, they anticipate to-morrow, and lay up store against the time to come. Many a goodly forest of oaks has risen from acorns planted by squirrels for future consumption and then forgotten.

We can explain this habit of storing food only by the one word, instinct. When we have applied that term we do not know how much it actually covers. The marmots and their allies, which associate in great communities on the prairies, the steppes, and up mountain sides, combining for defence and mutual assistance in as practical a communion as that of the beehive or the ant city—these are all imagined to be directed by instinct. When we see an isolated tamed marmot behaving, in entirely new conditions, as if it were still in a narrow burrow, running first forward, then backward, in an open space, as though operating in its narrow burrow, we realise that instinctive stimulation directs its actions. From that and from similar evidence we infer that all the wonderful story of its life, its city-building, its collecting and heaping up of winter supplies, its eager watchfulness for danger and instant communication of a discovery to the whole colony, proceeds from the same automatic impulse.

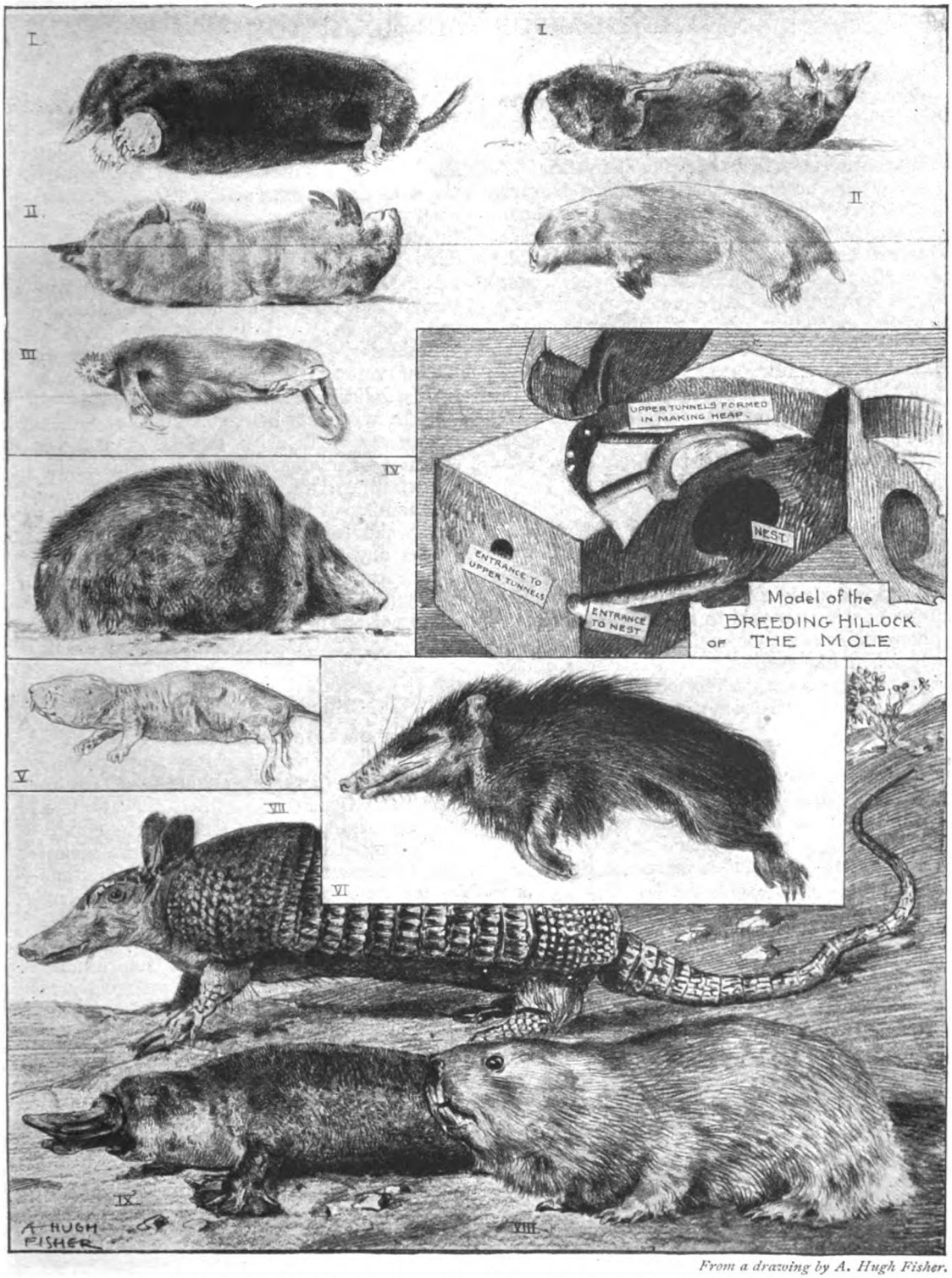
What is instinct, the mental quality which has brought these creatures of primitive brain to so high a pitch of organisation? It has been defined as "automatised reasoning," which would suggest that instinctive reasoning must have proceeded from reasoning which was not automatic, but spontaneous, actual. It seems impossible to ascribe the workmanship of that superlative engineer, the beaver, to mere blind instinct. None but a trained man can emulate the achievement of this sturdy rodent in the making of lodges, dams, and canals.

The beaver not merely dams a stream or river and converts it into pond or lake, whose water shall give safe entry and exit to his home, constructed below water-level; the plan on which the work is executed is what we should call highly scientific in man. The dams are built in the form of a crescent, with the bow facing upstream, so opposing the maximum resistance to the current. Openings are cut in the crest of the dam to permit the overflow of water. In time of flood the openings are widened to accelerate discharge; but afterwards the breach is narrowed to contain the water which remains. Canals are dug to facilitate the passage of logs to the beaver pond, excellent canals, with every obstruction removed from their course; and the catchment system for the collection of water is another marvel of ingenuity—wide, crescent-shaped dams again, but this time with the concave surface facing the water so that none shall run to waste.

Hibernating Animals

The rodents, then, have recourse, in their ways of making a living, to the very extremes of mental activity and inertia. They achieve wonders of engineering skill in their cities and fortresses; they provide for the days to come; in the case of the rat they outwit us in spite of all our science and ingenuity. On the other hand, we find in the same order groups of animals which pass the half of their lives hibernating, torpid as tortoises in winter, inactive as a frog in the mud at the bottom of a frozen pond. Offhand it might be urged that this very faculty—the ability to endure this long, death-like sleep—is evidence of the primitive lowly character of the order, but we must remember that so highly developed an animal as the bear, in the northern latitude of its range, also hibernates. Hibernation is one of the assets of this remarkably adaptive order of rodents which have enabled its members to overspread the earth and succeed in every condition of life.

The diversity marking habit and haunt of the rodents extends also to their natural furnishing in the matter of raiment. Nature has almost run the gamut in the rodents'



From a drawing by A. Hugh Fisher.

The rodents or gnawing animals include thousands of species. The group displays a marked diversity of form, habitat, size, degree of intelligence and method of living, but all the members of the group have one feature in common—the teeth. The burrowing mammals shown above are:—I. Common Mole (*Talpa Europœus*). **II. Marsupial Mole** (*Notoryctes Typhlops*). **III. Star-nosed Mole** (*Condylura Cristata*). **IV. Golden Mole** (*Chrysochloris Trevelyani*). **V. Naked Sand Rat** (*Hetero-Cephalus Glaber*). **VI. Tenrec** (*Centetes Ecaudatus*). **VII. Armadillo** (*Tatusia Novemcincta*). **VIII. Bamboo Rat** (*Rhizomys Chinensis*). **IX. Duckbill or Platypus** (*Ornithorhyncus Anatinus*).

attire. Some of our most treasured furs are derived from this order. The chinchilla, the musquash, the squirrel of commerce at once come to mind, but we need to be reminded that the so-called camel's hair brush is really the product of the common squirrel. We do not, however, surrender all the rodent externals to commerce. Among the external coverings of this order we have fur of the finest texture, hair which is more bristles than true hair; we have true scales mixing with fur, scales which act as a defence, concealed in the fur; scales which enable their owners to climb; we have prickles and spines, culminating in the magnificent armament of the porcupine. The porcupine's quills, gay and ornate as they are, arise simply from modified hair, as does the horn of the rhinoceros.

Nuptial Pelts

They are primarily an armament, but we cannot fail to see that they play their part in the matter of ornamentation by which one sex is attracted to another. The handsomest, bravest, or wiliest rodent wins the bride of his seeking, and the quills of the porcupine undoubtedly come prominently into the scheme of wooing. One of the rodents, by the way, an American form of palm squirrel, is distinct among mammals as the only one which develops a courting dress. The nuptial pelt of this little beauty is as gay and attractive as the resplendent colour scheme into which the weaver birds change when nesting days are nigh.

In dealing with an order comprising so many species, it is, of course, impossible to refer in detail to individual genera, but consideration of general characteristics have a special interest for us all from the fact that, next to the horse, dog and cat, rodents come more intimately into our lives than any other group of animals.

Many a man has been first won to nature study by possession of those prizes dearest to a healthy boy's heart, tame rats, mice, guinea-pigs, rabbits, perhaps a jerboa or two, a little colony of dormice, and a couple of squirrels scuttling about the room. They all flourish in kindly captivity, though the families of some of them may outgrow the limits of our hospitality. In so doing they remind us that nature herself seems unable to deal with the unfettered generations in the wilds save by impelling them to commit a wholesale hari-kari.

There is no stranger phenomenon in natural life than the mass suicide of those most interesting of voles, the lemmings. What urges them to their doom none can say, though the preliminary stages of the great march to death are clearly comprehended. Death and destruction hasten upon the heels of excessive prosperity. A lemming colony is well stocked with animals when there comes an early spring, bringing abundant food. Increase of rations is always accompanied by increase of population among the animals for which such food is suitable. Favoured by circumstances, the lemmings grow immensely in numbers.

The verdant spring is followed by an early summer, and the result is disastrous. We know what happens in the English strawberry fields in like circumstances. Untimely heat brings on the fruit before the average date, and cuts down the size and number of fruit to a minimum. A crop which should last three weeks at least is picked and disposed of in seven or eight days. And so in the lemming world the food which should have held out until the coming of autumn, is scorched and withered, and there is not a green blade for a lemming to eat.

Migrating Lemmings

It cannot be asserted that every one of the lemmings departs, for new colonies appear in time whence an older colony has vanished. Queen bees, when they fight at the end of the season, desist from combat when they realise that both are in a position to receive a mortal wound simultaneously; and it may be that some few lemmings remain behind in the old citadels to restock the deserted ways, though possibly re-colonisation takes place from another source. Be that as it may, practically all the teeming population of the crowded haunts sets forth in a body on a migration from which there is no returning. In hosts beyond enumeration the little animals march in ardent haste, straight forward, brooking no resistance, avoiding no obstacle. They scale hills and descend ravines, they cross lakes and rivers; they traverse cultivated fields, they rush over ricks and stacks, they stream through houses, they crowd through streets and alleys, ever onwards to their doom.

By that mysterious telegraphy which carries news afar in the animal world, the enemies of the lemmings are gathered from all quarters upon the flanks of the cavalcade of tragedy: birds, wolves, foxes, devour the unresisting prey. Starvation strikes down multitudes of the animals as they

FUR BREEDING ANIMALS.

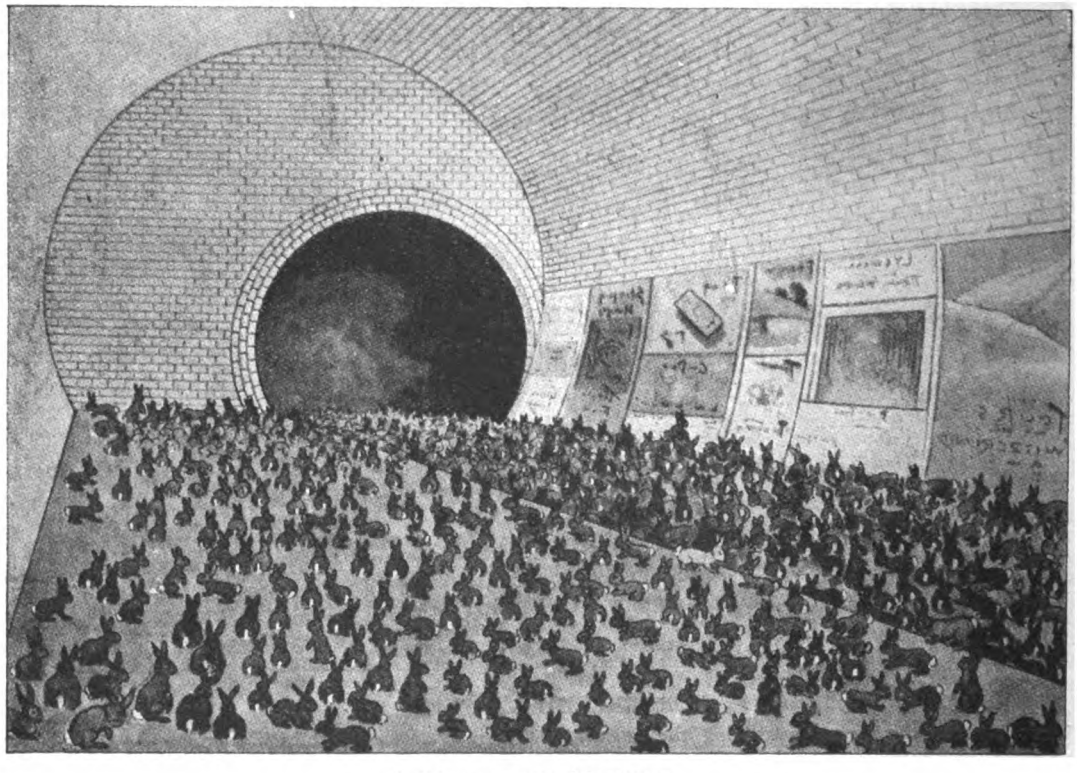
Nature has run the gamut in attiring the rodents, which provide the most highly treasured of furs. The chinchilla, musquash, and squirrel of commerce at once come to mind; whilst the so-called camel's hair brush is in fact a product of the common squirrel.

progress; their track is marked by lines of corpses. But nothing deters the survivors. They struggle on with frenzied vitality until their goal is reached. That goal is the sea, and into it they plunge, never more to emerge.

The former denizens of the mountain slopes become food for fishes, and the tragedy is complete. The migration of bison, when herds were in their prime, and of springboks when they were plentiful as rabbits, were known and explicable; the migration of birds, wonderful and fascinating in its operation, is easy of comprehension; the great journeys of fishes from ocean depths to inshore waters, from inshore waters to the sources of the rivers in which they were hatched—all these phenomena can be grasped and their riddle read. But the story of the lemmings' end baffles us. It seems instinct run mad. It must have originated in migrations which led to new food supplies, but now food supplies are not even sought. The march is straight to death, regardless of prospects by the way. It has become a natural law among lemmings, and a naturalist on the spot, given the necessary data—great number of animals, early spring and fierce summer heat—can predict the coming of this co-operative act of suicide as confidently as the astronomer can predict an eclipse.

The phenomenon can be witnessed in certain districts of Norway and Sweden, where ordinarily lemmings are unknown. It occurs at intervals varying from five to twenty years. The lemmings only travel by night; and during the journey they multiply to an extraordinary degree, their families being even larger and more frequent than usual.

It surely is the strangest development of instinct in the animal world. It seems now as if it were almost intended as a check upon over-population. Such checks are absolutely necessary in the scheme of animal life, for were this great order of rodents left to multiply without catastrophic hindrance, they would attain such numbers as to eat the earth bare and leave all animate creation, themselves and ourselves included, to perish of starvation. As it is, they are among the most formidable competitors that humanity has to cope with. E. A. B.



A MENACE TO MANKIND.

One of the serious facts of life is the abounding fecundity of the rodents. The progeny of one pair of rabbits, were they all to come to maturity, would in three years fill all the Tube Railways of London.

ASTRONOMY.—VI

THE professional astronomer is often very ignorant of the general aspect of the sky, and of the names of the stars. This comes of using telescopes which are set to the required position by tables, and which show so small a piece of the sky in the field of view that in the majority of cases there is no single star in the field which is visible to the unaided eye. Under these circumstances one does not get a good knowledge of the constellations. But to the lover of astronomy who is not obliged to devote all the hours of clear weather to serious work, there is much pleasure and interest to be gained from a good knowledge of the stars and their constellations, such as may be obtained from a comparison of the sky with the maps of a good star atlas. And there are certain inquiries, of no inconsiderable interest, which can be prosecuted without any telescopic aid by those who are seriously resolved to do something useful.

Path of Meteors

There is, to take one example, the study of meteors, which requires an instantaneous knowledge of the names and numbers of the stars among which the meteor flashes for an instant. No instrumental means, not even the photographic plate, cover a sufficient range of the sky to be of any serious use in recording the tracks of these small visitors from outer space, which come to a brilliant but brief end through conflagration by friction in the upper air. We know nothing of any individual meteor until a second or two before the end of its actual career.

After its flash in the air the material which has been for this brief instant dissipated into brilliant vapour will condense again, and sink gradually to earth as meteoric dust, to stain the arctic snows or the ooze of the deep sea bottom. But much may be learned of the meteor's previous history, if the apparent path among the stars of its last trail can be seized and recorded before it fades away. There are some practised observers who can say to themselves that the path began so many degrees east and north of a particular star, and ended at a similarly defined point; and so can record practically all there is to be derived from the observation itself.

But most observers will find that it is desirable to have before them a chart on which to plot with pencil and ruler the path of the meteor among the stars. The difficulty is, of course, that one wants to have a chart of a very large area of the sky, which cannot be shown without some distortion. Also the chart becomes soaked with dew, which later in the night may change into a film of ice, so that for real comfort it is well, if possible, to prepare charts on thin paper, that can be placed on a sheet of glass over a lamp which serves a double purpose, of lighting them up and keeping them dry. Each man will work out his details for himself. It is more important here to remark upon the interest of that information concerning the meteors which can be accumulated by an ardent observer.

Observation shows that meteors do not come promiscuously from all parts of the sky, but that there are radiant points from which a considerable proportion of the meteors observed on any one night will be found to proceed. They radiate from a point owing to the effect of perspective. The point from which they radiate marks the direction from which they meet the motion of the earth in its orbit.

Though scattered meteors belonging to no recognised family will help to confuse the uninitiated, experience will show that a large percentage of the whole number observed will belong to one or other of the radiants whose positions have been learned by slow degrees. And there is a very curious thing about these radiants: according to theory, they ought to shift during the night and from one night to another, as the direction of motion of the earth itself changes. But the best observers declare that this is not the case, except for one or two well-known showers. They say that for a number of nights meteors will radiate from an unchanging point in the sky; which is so clearly contrary to theory that it requires perhaps more precise confirmation than it has yet received. Here is an ample field of work for the astronomer without a telescope.

Zodiacal Light

Then there are the phenomena of the Zodiacal Light and the Gegenschein, which are by no means fully understood. They are not so conspicuous in England as they are in the Tropics; but the careful observer in spring will notice that in the west, when the sun has fully set and twilight has gone, there will be a faint glow extending up along the ecliptic, making itself apparent rather as a dimming of the background of stars than as a definite object in itself. Careful observation will show that it is roughly conical, though with somewhat curved sides coming to a point in the ecliptic.

Its origin is mysterious. It is generally

supposed to be due in some way to the reflection of sunlight from scattered particles lying principally in the plane of the earth's motion—a plane from which the other planets do not far depart. But there is evidence to show that it is not precisely symmetrical in form, or in its relation with this plane ; and it is important that every opportunity should be taken of defining its shape more precisely.

The Gegenschein is a faint patch of light of similar appearance to be seen about the middle of the night opposite to the place of the sun. It is more difficult to see than the Zodiacal Light, and observations of it are by no means unanimous in deciding what is its shape or whether it is precisely opposite the sun. Speculative people have suggested that the earth has a tail like a comet ; and that the Gegenschein is the tail. One man at least has asked us to suppose that the Gegenschein is only the sun seen the wrong way round in curved space of four dimensions ; but this is going out altogether beyond the range of legitimate speculation.

It is not likely that its real nature will be determined until we have far more numerous and precise observations of it than we have at present. Those fortunate star-gazers who live far from the glare of towns, especially within the Tropics, could do useful work in looking for the Gegenschein, and making precise records of its shape and boundaries at given times.

Nothing new is to be learned about the green flash at sunset ; but its observation is attended with some difficulty, and the attempt to see it often provides a pleasant break in the tedium of a sea voyage. Its explanation is simple. When the sun has almost set, so that the last remaining segment is reduced nearly to a straight line, refraction will spread it out vertically into a nearly pure spectrum with the red below and the violet above. The red end is, of course, confounded with the disappearing red disc of the sun ; the violet end is lost in the blue sky, but the very brilliant blue-green is seen for an instant after the red has set and disappeared, and gives rise to the phenomenon of the green flash.

It is somewhat difficult to observe, because looking at the bright sun produces a fatigue

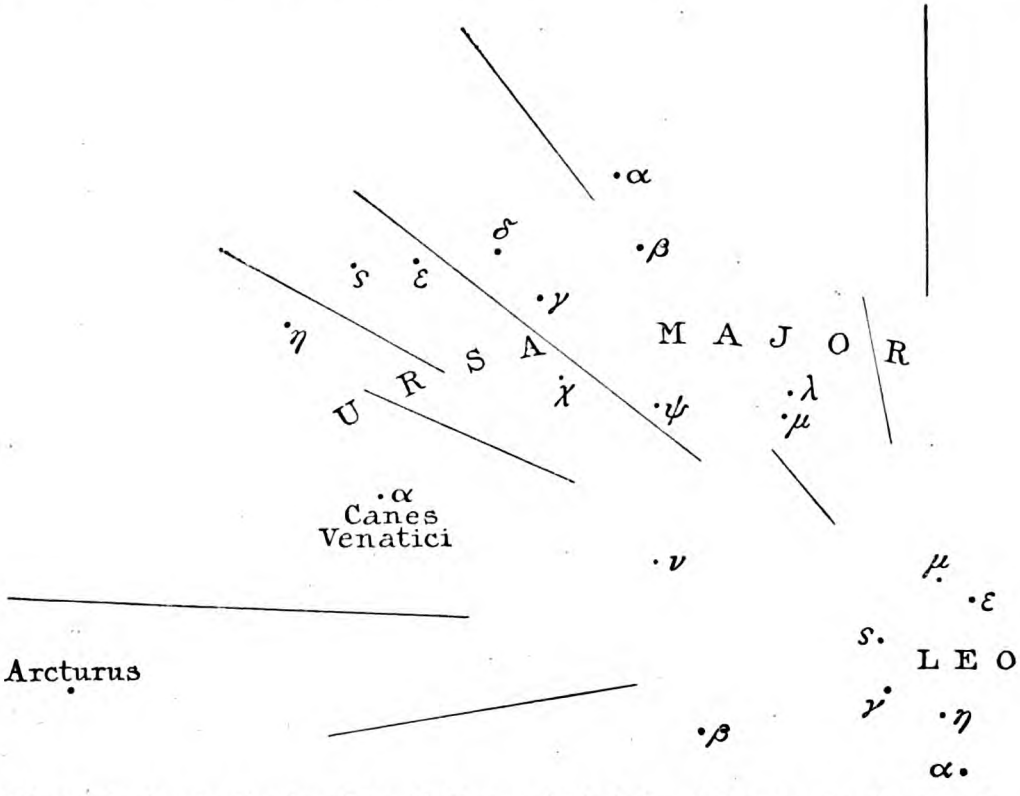


Diagram showing the direction of Leonid Meteors. This family of Meteors radiate from a point marking the position of the Leo Stars (*See p.* 349).

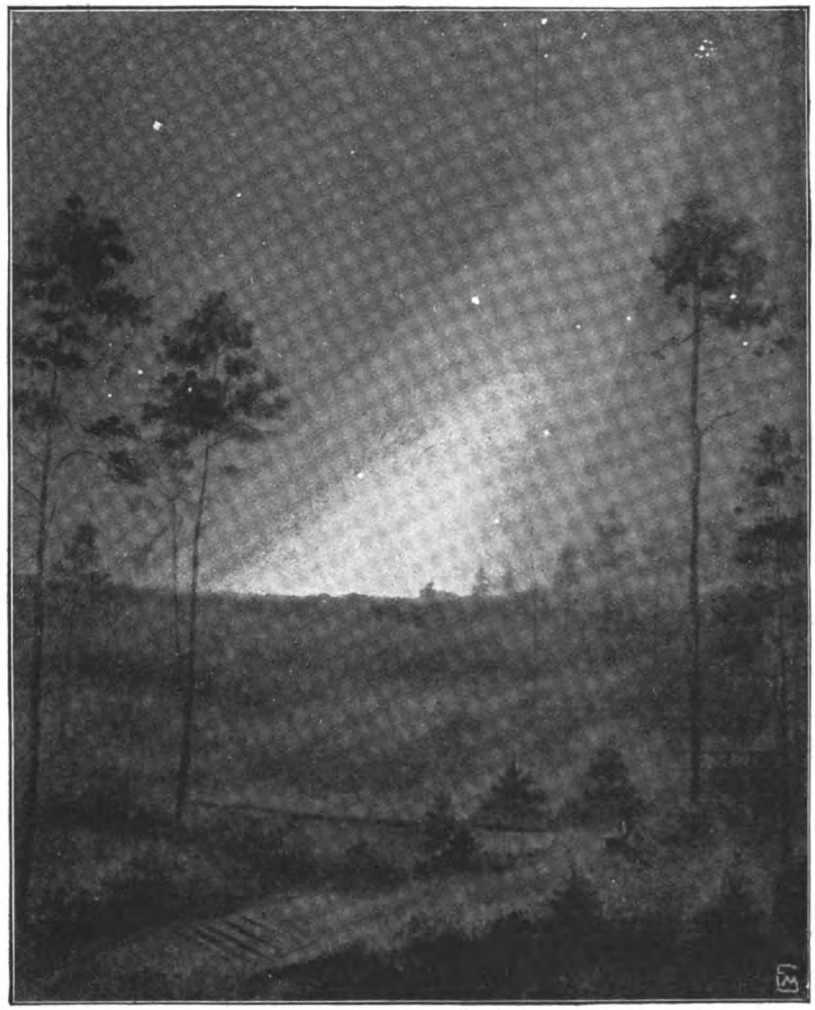
of the retina which results in the well-known effect of the green after-image, frequently confounded with the green ray, and not altogether easy to avoid. Anyone looking at the sun fixedly as it is setting, and when it is not too bright to be stared at in comfort, will find when he turns away that he can see bright green patches in front of him wherever he looks, which fade away very quickly, and are renewed with every blink of the eyelids. It is most important to avoid any chance of this effect if one is looking at the green flash, so the best thing to do is to get a friend to watch until the sun has almost disappeared, and then give the signal to the would-be observer, who can thus, to a great extent, avoid the fatigue of the eye which gives the spurious green image.

A still better way is to look for the effect at sunrise when a green flash precedes by an instant the first appearance of the sun; but this observation is not so often made.

Speaking of the disappearing sun being reduced almost to a line reminds us that there are simple ways of observing the spectrum of the sun which are amusing to practise. The books tell us that, to get a spectrum of the sun to show the dark lines, one should have a spectroscope with a narrow slit and a fairly complicated arrangement of prism and lenses. A very efficient slit can be found wherever there is a door facing the sun. By opening the door a little, and standing behind it at some distance, one can generally find a position in which the sun will stream through a quite narrow slit between the door and the door jamb.

A very simple prism, such as a fragment of one of the cut-glass prismatic chandeliers which have come into fashion again, is quite sufficient to give a very useful spectrum, if one puts it close to the eye with an edge parallel to the slit of the door and looks at the sun through it. Quite a number of dark lines will be seen crossing the band of colour, notably in the yellow, green, and blue green. The double line of absorption in the yellow tells of the presence of sodium in the sun's atmosphere. The line in the blue-green is one of the series produced by hydrogen. There are many others which can be seen with a little skill and patience.

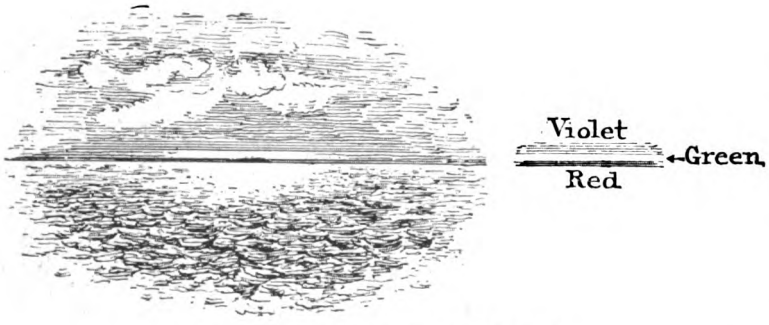
It will be remembered that dark lines



THE ZODIACAL LIGHT.
a faint glow, roughly conical in shape, seen in the west when the sun has fully set and twilight has gone.

crossing a bright spectrum mean that light from a glowing solid body has passed through layers of absorbing gases, and lost the particular rays which are characteristic of those gases when they are shining themselves. The ray in the yellow was missing from the spectrum of the sun because there is relatively cool sodium vapour in the atmosphere of the sun above the layer which is the principal source of white light.

One of the big yellow arc lights which are now so commonly used for street lighting, will show very well the same sodium line—but this time bright, because the arc is full of hot, luminous sodium vapour derived from the material with which the carbons are cored. If one gets far enough away from one of these lamps to reduce the source of light practically to a point, the same prism will show a bright spectrum with the sodium lines standing out as an intensely bright point on it, very much like the characteristic spectrum of a new star.



THE GREEN FLASH AT SUNSET.

When the sun is almost set, refraction will spread it out vertically into a nearly pure spectrum. The red below is lost in the disappearing disc of the sun, and the violet above is lost in the blue sky, but a brilliant blue green is seen for an instant after the red has set.

The discovery of brilliant new stars is a rather precarious occupation which can hardly be recommended seriously to an amateur astronomer, because the appearance of such a star is very infrequent. But it must not be forgotten that it was an amateur, Dr. Thomas Anderson, of Edinburgh, who discovered the two most famous new stars of our time: Nova Aurigæ in 1892, and Nova Persei in 1901.

Such a distinction may at any moment fall to the lot of anybody who knows his stars really well, and can say with confidence whether or not any particular star is or is not normally in that place. The most illustrious telescopic observer of the present day saw Nova Persei when he was on a voyage across the Pacific to observe an eclipse of the sun. He confesses that he said to himself that he did not remember there was a bright star there, and thought no more of the matter.

The appearance of conspicuous new stars is, however, so comparatively uncommon that search for them can hardly be pursued as an end in itself; but it may very usefully be combined with a search for the variable stars, of which class the new stars are only extreme examples. Quite a number of the bright stars in the sky visible to the naked eye are, to some extent, variable in brightness, and it is extremely probable that patient and acute observation will detect variability in others that are now believed to be constant. Therefore, it may be useful to indicate, very briefly, the manner in which those observations may be made.

One forms a sequence, or series of stars, each a little fainter than the next preceding, and after some time one can arrive at a scale of so-called "steps" of magnitude, a step being the least difference in brightness which an observer can detect.

One takes this series of stars and arranges them in order of brightness. For simplicity let us think of the two stars E and F. If E is made brighter than F as often as F is made brighter than E, one may take them as being in reality of the same brightness, unless, indeed, one of them is really variable; but if E is made brighter than F twice as often as F is made brighter than E, the presumption is that E is really brighter than F by a small amount which one may call one step, or possibly, in practice make it two steps; while if E is very nearly always brighter than F but just once in a while the judgment is reversed, one might call E three steps brighter than F.

It must always be remembered that absorption of light by the air makes stars grow fainter as they approach the horizon, so that comparisons should, as far as possible, be made when the stars to be compared are at the same altitude. There is also, in most

observers, a strong tendency to make the upper of the two equal stars systematically brighter or fainter than the lower, so that if two stars to be compared are not of the same altitude the head should be turned until the line joining the stars is parallel to the line joining the eye.

The observation of these sequences of stars is an interesting piece of work which may, at any moment, provide a surprise in the shape of a new variable, and which will, at any rate, introduce the observer to the presence of systematic errors, an appreciation of which is the first requisite of successful observation of any kind.

In the infrequent circumstances of a total eclipse of the sun there are certain observations of interest which can be made only with the naked eye, such as the colour effects, and the shadow bands which precede the coming of the shadow of the moon at totality. But the observation of total eclipses of the sun hardly comes within the scope of everyday astronomy, and there is always plenty of opportunity of learning what may usefully be done when one is so fortunate as to be in a position to look forward to an eclipse.

In eclipses of the moon, which are much more common than those of the sun at any one place, because they are visible over a whole hemisphere at once, there is little to be done except to observe the colour of the eclipsed moon. Sometimes the moon is quite bright, of a fine coppery-red colour; and sometimes it is so black that it can hardly be seen, the difference being caused, presumably, by the state of the atmosphere, cloudy or clear, round the belt of the earth where the eclipsed moon is seen just on the horizon.

It is easy to show that an observer on the moon would never see a clear-cut eclipse of the sun by the earth, for there will always be a more or less bright ring of light surrounding the earth, due to the refraction of sunlight in the atmosphere; and the fact that we see nothing of such an effect in an eclipse of the sun by the moon is one of the proofs that the moon has no effective atmosphere.

A. R. H.

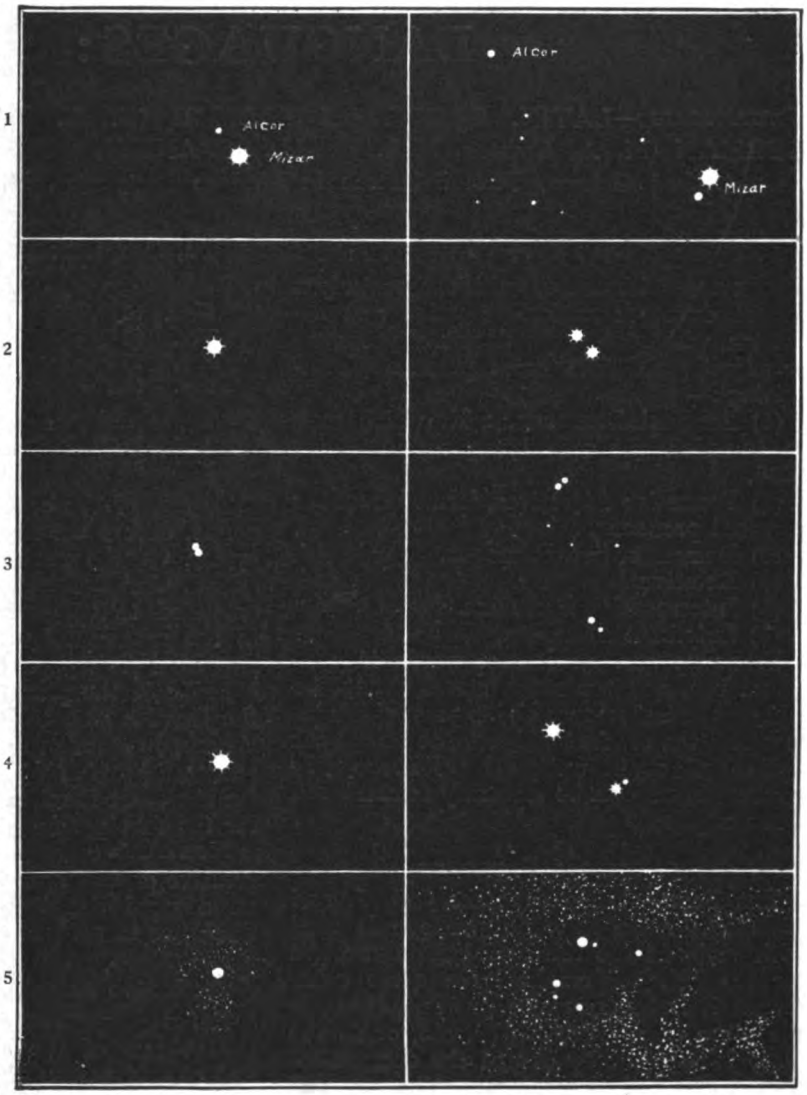


Chart of compound stars, as seen with the naked eye (on the left), and in the telescope (on the right).

1. Mizar in Ursa Major. 2. Castor in Gemini.
3. The fourfold star in Lyra. 4. Alamak in Andromeda.
5. Trapezium, in the interior of the Great Orion nebula.

Continued from page 296

LANGUAGES:

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LATIN.—VI

THE present lesson, to which the student should devote considerable pains and attention, will treat of six classes of pronouns or adjectives derived from pronouns, comprising :—

(1) Personal Pronouns, with which may be included the reflexive pronoun **sē** or **sēsē**.

(2) Possessive Adjectives, formed from the personal pronouns.

(3) Demonstrative Pronouns.

(4) Relative Pronouns.

(5) Interrogative Pronouns.

(6) Indefinite Pronouns.

Pronouns are, of course, words in continual use, and too much stress cannot be laid on the importance of the present lesson, to which the student will have to refer back again and again until all are thoroughly mastered and can be instantly remembered when required.

Personal Pronouns

The Personal Pronouns are **ĕgŏ**, *I*, and **tū**, *thou*. As a rule, no pronoun is used with verbs in the third person. But when for the sake of emphasis or some other reason it is necessary to put something in the place of the English *he*, *she*, or *it*, the place is supplied by one of the demonstratives to be considered later. The personal pronouns, which are substantive and of common gender, are declined as follows :—

Ĕgŏ, *I* (first personal pronoun)

	Sing.	*Plur.*
Nom.	ĕgŏ	nō-**s**.
Acc.	mē	nō-**s**.
Gen.	mē-**ī**	nos-**trī** *or* nos-**trūm** (partitive).
Dat.	mĭ-**hĭ**	nō-**bīs**.
Abl.	mē	nō-**bīs**.

In the dat. sing. **mī** is sometimes found instead of **mihĭ**, especially in poetry.

Tū, *thou* (second personal pronoun)

	Sing.	*Plur.*
Nom.	tū	vō-**s**.
Voc.	tū	vō-**s**.
Acc.	tē	vō-**s**.
Gen.	tŭ-**ī**	ves-**trī** *or* ves-**trūm** (partitive).
Dat.	tĭ-**bĭ**	vō-**bīs**.
Abl.	tē	vō-**bīs**.

To any of the cases of the personal pronouns, except the nom. sing. of the second person **tū**, the particle **-mĕt** is sometimes added, thus **ĕgŏmĕt**, **sĭbĭmĕt**, etc. ; **tū** is extended to **tūtĕmĕt**. It gives emphasis to the pronoun, **ĕgŏmĕt** answering to the English *I for my part*.

In Latin the plural **vōs** is not used, like the English *you*, to denote a single person. When *you* stands for one person it must be rendered by **tū**, *thou*, with its various cases. On the other hand, **nōs** is occasionally used for the first person singular.

Nostrum and **vestrum** are used for the genitive of **nōs** and **vōs** when they depend on a word denoting part of a collective whole, as in **aliqui vestrum**, *some of you*.

Reflexive and Possessive Pronouns

Reflexive pronouns are such as refer to the subject of the sentence. In the first and second person the oblique cases of the foregoing personal pronouns are used as reflexives (obviously a nominative is not needed), but for the third person the form **sē** or **sēsē**, *himself*, *herself*, *itself* or *themselves*, is used, declined as follows :—

	Sing. and Plur.
Acc.	sē (*or* sēsē)
Gen.	sŭ-**ī**
Dat.	sī-**bi**
Abl.	sē (*or* sēsē)

To **sĭbĭ** or **sē** the particle **-mĕt** may be added for emphasis, as in **sĭbĭmĕt**, **sĕmĕt**.

The Possessive Pronouns are **mĕŭs**, *my, mine*, **tŭŭs**, *thy, thine*, **nostĕr**, *our, ours*, **vestĕr**, *your, yours*, and **sŭŭs**, *his, her, their*, or *theirs*, formed from the preceding personal pronouns, and **cūiŭs**, *whose, is*, formed from the relative **quī**. **Mĕŭs** is declined like **bŏnŭs**, except that the voc. sing. is **mī**, thus :—

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	mĕ-**ŭs**	mĕ-**ă**	mĕ-**um.**
Voc.	m-**ī**	mĕ-**ă**	mĕ-**um.**
Acc.	mĕ-**um**	mĕ-**am**	mĕ-**um.**
Gen.	mĕ-**ī**	mĕ-**ae**	mĕ-**ī.**
Dat.	mĕ-**ō**	mĕ-**ae**	mĕ-**ō.**
Abl.	mĕ-**ō**	mĕ-**ā**	mĕ-**ō.**
		Plur.	
	Masc.	*Fem.*	*Neut.*
Nom.	mĕ-**ī**	mĕ-**ae**	mĕ-**ă.**
Voc.	mĕ-**ī**	mĕ-**ae**	mĕ-**ă.**
Acc.	mĕ-**ōs**	mĕ-**ās**	mĕ-**ă.**
Gen.	mĕ-**ōrum**	mĕ-**ārum**	mĕ-**ōrum**
Dat.	mĕ-**īs**	mĕ-**īs**	mĕ-**īs.**
Abl.	mĕ-**īs**	mĕ-**īs**	mĕ-**īs.**

Like this are declined :—

tŭŭs, tŭa, tŭum, *thy, thine.*
sŭŭs, sŭa, sŭum, *his, her, its, their, theirs.*
cūiŭs, cūiă, cūiŭm, *whose, whose?*

These have no vocative. Like **sē**, **sŭŭs**, except in the nominative, usually refers to the subject of the sentence. Thus **venit in domum suum** means *he came into his* (own) *house;* but **venit in domum eius**, *he came into his* (someone else's) *house.*

The possessives formed from **vōs** and **nōs** are declined like—

nostĕr, nostră, nostrum, *our, ours.*
vestĕr, vestră, vestrum, *your, yours.*

Vestĕr has no vocative.

The particle **-ptĕ** is sometimes added for emphasis to the abl. sing. of the possessive adjectives, thus **meoptĕ**; **-mĕt** is similarly added to **sŭŭs**, thus **sŭōmĕt.**

From **nostĕr** and **vestĕr**, and from the interrogative **cūiŭs** are formed adjectives ending in **-ās**, gen. **-ātis**, thus :—

nostrās, -ātis, *of our country.*
vestrās, ātis, *of your country.*
cūiās, -ātis, *of what country?*

Demonstrative Pronouns

The Latin Demonstrative Pronouns are the following : **hĭc**, *this*, **istĕ**, *that* (near you), and **illĕ**, *that* (near him or yonder) ; and three sometimes called determinative pronouns, **ĭs**, *he* or *it*, **īdem**, *the same*, and **ipsĕ**, *self, same.* They are used, precisely as *this* or *that* in English, both substantively and adjectivally. The following declensions must be carefully learned :—

Hĭc, haec, hŏc, *this* (near me).

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	hī-**c**	ha-**ec**	hō-**c.**
Acc.	hu-**nc**	ha-**nc**	hō-**c.**
Gen.	hū-**iŭs**	hū-**iŭs**	hū-**iŭs.**
Dat.	hu-**ic**	hu-**ic**	hu-**ic.**
Abl.	hō-**c**	hā-**c**	hō-**c.**
		Plur.	
Nom.	hī	hae	hae-**c.**
Acc.	hō-**s**	hā-**s**	hae-**c.**
Gen.	hō-**rum**	hā-**rum**	hō-**rum.**
Dat.	hī-**s**	hī-**s**	hī-**s.**
Abl	hī-**s**	hī-**s**	hī-**s.**

Istĕ, istā, istŭd, *that* (*of yours* or *near you*).

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	ist-**ĕ**	ist-**ă**	ist-**ŭd.**
Acc.	ist-**um**	ist-**am**	ist-**ŭd.**
Gen.	ist-**iŭs**	ist-**iŭs**	ist-**iŭs.**
Dat.	ist-**ī**	ist-**ī**	ist-**ī.**
Abl.	ist-**ō**	ist-**ā**	ist-**ō.**
		Plur.	
Nom.	ist-**ī**	ist-**ae**	ist-**ă.**
Acc.	ist-**ōs**	ist-**ās**	ist-**ă.**
Gen.	ist-**ōrum**	ist-**ārum**	ist-**ōrum.**
Dat.	ist-**īs**	ist-**īs**	ist-**īs.**
Abl.	ist-**īs**	ist-**īs**	ist-**īs.**

Illĕ, illă, illŭd, *that* (*near him* or *yonder*).

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	ill-**ĕ**	ill-**ă**	ill-**ŭd.**
Acc.	ill-**um**	ill-**am**	ill-**ŭd.**
Gen.		ill-**ĭŭs.**	
Dat.		ill-**ī** (or in poetry oll-**ī**).	
Abl.	ill-**ō**	ill-**ā**	ill-**ō.**
		Plur.	
Nom.	ill-**ī** (or in poetry oll-**ī**)	ill-**ae**	ill-**ă.**
Acc.	ill-**ōs**	ill-**ās**	ill-**ă.**
Gen.	ill-**ōrum**	ill-**ārum**	ill-**ōrum.**
Dat.		ill-**īs** (or in poetry oll-**īs**).	
Abl.		ill-**īs** (or in poetry oll-**īs**).	

ĭs, ĕă, ĭd, *that* (or *he, she, it*).

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	ĭs	ĕă	ĭ-**d.**
Acc.	ĕ-**um**	ĕ-**am**	ĭ-**d.**
Gen.	ĕ-**iŭs**	ē-**iŭs**	ē-**iŭs.**
Dat.	ĕ-**ī**	ĕ-**ī**	ĕ-**ī.**
Abl.	ĕ-**ō**	ĕ-**ā**	ĕ-**ō.**

		Plur.	
	Masc.	*Fem.*	*Neut.*
Nom.	ĭ-ī (or ĕī)	ĕ-**ae**	ĕ-**ă.**
Acc.	ĕ-**ōs**	ĕ-**ās**	ĕ-**ă.**
Gen.	ĕ-**ōrum**	ĕ-**ārum**	ĕ-**ōrum.**
Dat.		ĭ-**īs** (or ĕ-**īs**).	
Abl.		ĭ-**īs** (or ĕ-**īs**).	

Idem, ĕădem, ĭdem, *the same.*

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	īdem	ĕădem	ĭdem.
Acc.	ĕundem	ĕandem	ĭdem.
Gen.		ĕiusdem.	
Dat.		ĕīdem.	
Abl.	ĕōdem	ĕādem	ĕōdem.
		Plur.	
Nom.	īdem (or īīdem)	ĕaedem	ĕădem.
Acc.	ĕosdem	ĕasdem	ĕadem.
Gen.	eōrundem	ĕārundem	ĕōrundem.
Dat.	isdem (or ĕisdem).		
Abl.	isdem (or ĕisdem).		

Ipsĕ, ipsă, ipsum, *self, same, that very person.*

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	ips-**ĕ**	ips-**ă**	ips-**um.**
Acc.	ips-**um**	ips-**am**	ips-**um.**
Gen.		ips-**ĭus.**	
Dat.		ips-**ī.**	
Abl.	ips-**ō**	ips-**ā**	ips-**ō.**
		Plur.	
Nom.	ips-**ī**	ips-**aĕ**	ips-**ă.**
Acc.	ips-**ōs**	ips-**ās**	ips-**ă.**
Gen.	ips-**ōrum**	ips-**ārum**	ips-**ōrum.**
Dat.		ips-**īs.**	
Abl.		ips-**īs.**	

The particle **-cĕ** or **-c** is sometimes added to the oblique cases of these demonstrative pronouns, but is comparatively rare except in the nominative **hīc**, **haec**, **hōc**, where they are inseparable. Thus we get the forms gen. **hūiuscĕ**, acc. plural, **hoscĕ**, **hascĕ**, and dat. and acc. plur. **hiscĕ**. This particle added to **istĕ** yields the forms :—

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	ist-**ic**	ist-**aec**	ist-**uc.**
Acc.	ist-**unc**	ist-**anc**	ist-**uc.**
Gen.		ist-**ĭuscĕ.**	
Dat.		ist-**ī.**	
Abl.	ist-**oc**	ist-**ac**	ist-**oc.**
		Plur.	
Nom.	ist-**īcĕ**	ist-**aec**	ist-**aec.**
Acc.	ist-**oscĕ**	ist-**ascĕ**	ist-**aec.**
Gen.	ist-**ōrunc**	ist-**ārunc**	ist-**ōrunc.**
Dat. Abl.		ist-**iscĕ.**	

In the same way we get **illĭc**, **illaec**, **illūc** (or **illōc**) from **ille**, etc.

VOCABULARY

ămābĭlis, -e, *lovely, amiable.*
ămīcĭtĭa, -ae (f.), *friendship.*
annŭs, -ī (m.), *year.*
antĕ Christum, *before Christ.*
bĕātus, -a, -um, *happy.*
castră, -ōrum (n., pl.), *camp.*
hīc, haec, hōc, *this.*
hĭrundo, -ĭnis (f.), *swallow.*
hōra, -ae (f.), *hour, time.*
ĭnīmīcus, -a, -um, *hostile, unfriendly.*
mīles, -ĭtis (m.), *soldier.*
mūnĭfĭcus, -a, -um, *munificent.*
nĭhĭl (n.), *nothing.*
ŏdĭum, -ī (n.), *hatred.*
paucŭs, -a, -um, *few.*
paupĕr, -ĕris, *poor.*
post Christum nātum, *after the birth of Christ.*
praestans, -ntis, *illustrious.*
prudens, -entis, *prudent.*
quŏtus, -a, -um, *how many?*
rēs sĕcundae (f., pl.), *prosperity.*
Rōmānus, -a, -um, *Roman.*
schōla, -ae (f.), *school.*
sĭmŭlātio, -ōnis (f.), *pretence.*
vĕlox, -ōcis, *swift.*

Exercise 5

Translate into English :—

1. Lucretius et Vergilius omnium Romanorum poetarum optimi sunt. 2. Montes et silvae pulcherrima pars insulae sunt. 3. Brevius vitae tempus quam mortis est. 4. Omnium hominum praestantissimus Caesar est. 5. Hic annus millesimus nongentisimus quintus decimus post Christum natum est. 6. Trecenti et triginta quattuor pueri in schola sunt. 7. Quota hora est? Nona est. 8. Tria milia hostium in oppido manent. 9. Pater meus tuo quattuor annos major natu est. 10. Simulatio amoris pejor est quam odium.

Translate into Latin :—

1. Nothing is more lovely than virtue. 2. Poor people are often more munificent than rich. 3. Swallows are swifter than sparrows. 4. Of all men the wise is happiest. 5. In misfortune many men are more prudent than in prosperity. 6. Few are unfriendly to a good man. 7. In the two camps of the enemy there are eight thousand soldiers. 8. I have four letters from your father. 9. This is the six hundred and ninetieth year before the birth of Christ. 10. My daughter is wiser and more amiable than my son.

Key to Exercise 4

1. The foreigners remain at home in the city. 2. The desire of immortal glory calls brave men to arms. 3. Hope is the expectation of good, fear the expectation of evil. 4. With slow steps the queen comes to the temple. 5. Your love is not unknown to me, but even pleasing and delightful. 6. To kings the good are more suspected than evil persons. 7. No enemies remain in our hands. 8. He stretched suppliant hands to the immortal gods. 9. There is plenty of ripe and most pleasing fruit in the garden. 10. Even in misfortune hope comes into my mind.

1. Omnibus virtutibus mens regis nostri praedita est. 2. Facies amici nostri puerilis sed pulchra et grata mihi videtur. 3. Omnium urbium pulcherrima Roma. 4. Omnia animalia sensibus praedita sunt. 5. Spes in animis hominum semper manet. 6. Respublica nobis multa praemia virtutis dat 7. Facilis descensus Averno est. 8. Felicitas virtutis fructus est. 9. Manus supplices judicibus tendit. 10. Res adversae saepe homines ad virtutem vocant. E.A.B.

FRENCH.—VI

Numerals.—Given below is a list of the cardinal and ordinal numbers up to 20, with typical examples of the higher numbers. Do not mistake **un,** the numeral, for **un** the indefinite article, although it resembles this in taking e mute in the feminine. **Premier** and **second** alone among the ordinals have a distinctive feminine form, i.e. **première** and **seconde.** Note carefully that in numbers which are multiples of **cent** or **vingt, s** is added when there is no other number following ; thus—

quatre-vingts, 80, but quatre-vingt-un, 81. quatre-vingt-dix, 90, etc.
deux cents, 200, deux cent un, 201, trois cent quarante, 340.

Mille does not take the **s** in multiples, though it does when used in the sense of *miles*, thus—

deux mille, 2000 ; deux milles, *two miles.*

Observe that the numerals (except **cent** or **mille**) forming compound numbers are connected together either by the conjunction **et** or by a hyphen.

Cardinals.	*Ordinals.*
1, un, une.	premier, première.
2, deux.	second, seconde, or deuxième.
3, trois.	troisième.
4, quatre.	quatrième.
5, cinq.	cinquième.
6, six.	sixième.
7, sept.	septième.
8, huit.	huitième.
9, neuf.	neuvième.
10, dix.	dixième.
11, onze.	onzième.
12, douze.	douzième.
13, treize.	treizième.
14, quatorze.	quatorzième.
15, quinze.	quinzième.
16, seize.	seizième.
17, dix-sept.	dix-septième.
18, dix-huit.	dix-huitième.
19, dix-neuf.	dix-neuvième.
20, vingt.	vingtième.
21, vingt et un.	vingt et unième.
22, vingt-deux, etc.	vingt-deuxième, etc.
30, trente	trentième.
40, quarante	quarantième.
50, cinquante.	cinquantième.
60, soixante.	soixantième.
70, soixante-dix.	soixante-dixième.
80, quatre-vingts.	quatre-vingtième.
90, quatre-vingt-dix.	quatre-vingt-dixième.
100, cent.	centième.
101, cent un.	cent-unième.
200, deux cents.	deux-centième.
201, deux cent un.	deux-cent-unième.
1,000, mille.	millième.
1,001, mille un.	mille-unième.
2,000, deux mille.	deux millième.
1,000,000, un million.	millionième.

Note that in dates **mil** is used instead of **mille,** thus—

l'an mil huit cent soixante-douze. *The year* 1872.

Dates and Hours.—The cardinal numbers are used for the day of the month, except the *first*, for which the ordinal **premier** is employed, as in—

le dix août, le dix-sept juillet. *The 10th August, the 17th July.*
le premier du mois prochain. *The first of next month.*

The following idioms should be noted :—

quel jour est-ce aujourd'hui ? *What day is it to-day?*
c'est aujourd'hui le dix. *To-day is the tenth.*
quel jour sommes-nous ? *What day is it to-day?*
nous sommes le dix-sept. *It is the seventeenth.*
quel quantième du mois sommes-nous ? *What is the day of the month?*
nous sommes le quatre du mois. *It is the fourth of the month.*

Before the word **onze** the vowel of the article **le** or **la** is not elided, thus—

c'est aujourd'hui le onze décembre. *It is the eleventh of December.*

For the time of day, the word **heure,** *hour*, or **heures,** *hours*, stands for the English expressions *o'clock* or *time*, and must always be expressed ; thus—

quelle heure est-il ? *What time is it?*
il est une heure. *It is one o'clock.*
il est dix heures. *It is ten o'clock.*

For 12 *noon* **midi** is used, and for 12 *midnight*, **minuit : douze heures** is used only in the sense of a period of twelve hours. For the English *quarter past, half past*, the expressions **et quart** or **un quart** and **et demie** (agreeing with **heure**) are employed, thus—

il est neuf heures et un quart (or *et quart*). *It is a quarter past nine.*
il est une heure et demie. *It is half past one.*
il est midi et demi. *It is half past twelve* (noon).

In the last sentence, **demi** agrees with **midi.**

For the English *a quarter to, twenty minutes to*, etc., the expressions **moins un quart, moins vingt,** or **moins vingt minutes,** etc., are used, thus—

il est dix heures moins un quart. *It is a quarter to ten.*
il est neuf heures moins dix (minutes). *It is ten minutes to nine.*

The word **minutes** is omitted as often as not.

In speaking of age, the word **ans,** *years*, is always expressed, and the verb **avoir** is used idiomatically, thus—

quel âge avez-vous?	*How old are you?*
j'ai plus de vingt ans.	*I am more than twenty.*

Notice the use of the preposition **de** instead of **que** for *than*, in **plus de,** *more than*, **moins de,** *less than*, before numbers, as again in the following :—

avons-nous plus de dix mètres de cette toile de Hollande ?	*Have we more than ten metres of this holland?*
vous en avez moins de six aunes.	*You have less than six ells of it.*

Demonstratives. — The demonstrative adjective is **ce** (m.), **cette** (f.), **ces** (plur.), *this* or *that*. Before a word in the masculine singular beginning with a vowel or **h** mute the form **cet** is used. Examples :—

avez-vous ce parapluie ?	*Have you this umbrella?*
n'avez-vous pas cette bouteille ?	*Have you not this bottle?*
n'avez-vous pas cet argent ?	*Have you not this money?*
vous avez eu cet honneur.	*You have had this honour.*

To express the difference between *this* or *that*, in other words between an object near at hand or here, and one at a distance or there, the adverbial particles **ci** and **là** are appended to the substantives, thus—

je n'ai pas ce parasol-ci, j'ai ce parasol-là.	*I have not this parasol, I have that parasol.*

Ci and **là** may be compared with the vulgarisms *this here* and *that there*.

Possessive Adjectives.—The possessive adjectives **mon,** *my*, **ton,** *thy*, **son,** *his* or *her*, **notre,** *our*, **votre,** *your*, **leur,** *their*, agree in gender and number with the substantive following them, representing the object possessed, as follows :—

Masculine.	*Feminine.*	*Plural.*
mon	ma	mes *my*
ton	ta	tes *they*
son	sa	ses *his, her,* or *its.*
notre	notre	nos *our*
votre	votre	vos *your*
leur	leur	leurs *their*

Votre, notre, leur are used without variation in the feminine. Examples :—

mon père, *my father.*	ma lettre, *my letter.*
votre fusil, *your gun.*	votre cravate, *your cravat.*
notre argent, *our money.*	notre canne, *our cane.*
leur terre, *their land.*	leur père, *their father.*

Before a feminine noun in the singular beginning with a vowel or **h** mute, the masculine forms **mon, ton, son,** are used, instead of **ma, ta, sa,** to avoid the hiatus between two vowels, as in—

mon épée, *my sword.*	son habitude, *his* (or *her*) *habit.*
ton amitié, *thy friendship.*	

Be careful to observe that in gender the possessive adjective agrees not with the possessor but with the thing possessed.

VOCABULARY.

attentif, *attentive.*	mort, *dead.*
la bibliothèque, *the library.*	la mule, *the mule.*
le boulanger, *the baker.*	une paire, *a pair.*
la boutique, *the shop.*	pour, *for.*
domestique, *domestic,* le or la domestique, *the servant.*	la propriété, *property.*
	rétif, *restive.*
	le roi, *the king.*
une douzaine, *a dozen.*	la salière, *the salt-cellar.*
un franc, *a franc.*	le soldat, *the soldier.*
le front, *the front.*	studieux, *studious.*
l'habillement (m.), *the clothes.*	le volume, *the volume.*
	la gare, *the railway station.*
l'infortune (f.), *the misfortune.*	le fiacre, *the cab.*
inutile, *useless.*	le crépuscule, *the twilight.*
la mort, *death.*	la cuisine, *the kitchen.*

Exercise 9

1. Nous avons près de deux millions de soldats au front. 2. Deux mille quatre cent trente hommes sont morts. 3. J'ai un million de francs. 4. L'an mil huit cent quatre-vingt-dix-sept. 5. Louis quatorze était roi de France en l'an mil sept cent quatre. 6. C'est aujourd'hui le dernier du mois. 7. J'ai plus de trois mille volumes dans ma bibliothèque. 8. J'ai une douzaine de paires de bas de soie dans ma boutique. 9. Il est neuf heures dix. 10. Il est dix heures moins un quart. 11. Quel jour sommes-nous ? 12. Nous sommes le premier février. 13. Quel quantième du mois sommes-nous ? Nous sommes le dix-huit. 14. Quel âge avez-vous ? 15. J'ai dix-sept ans et six mois. 16. Avez-vous plus de quatre-vingts litres de ce vin ? 17. Cet homme-ci est un des plus grands fripons. 18. Cette belle maison est-elle la propriété de votre frère ? 19. La mort de votre père est une grande infortune pour tous. 20. Leurs efforts sont tout à fait inutiles.

Exercise 10

1. Has the servant this salt-cellar? 2. He has not this salt-cellar, he has that one. 3. Has the baker any biscuits ? 4. The baker has no biscuits, he has some bread. 5. His horses are not restive, but his mules are very restive. 6. Have you a pair of woollen stockings ? 7. I have a fine pair of silk stockings. 8. Has the physician the good houses or the bad ? 9. He has neither the good nor the bad ones. 10. My scholars (boys and girls) are very attentive, and very studious. 11. They are not very studious. 12. Their clothes are superb. 13. Is it the fifteenth day of the month ? 14. No, it is only the eleventh. 15. Have you the first or the second place ? 16. I have the first, and my brother has the second. 17. It is not yet two o'clock. 18. Is it half-past one ? 19. It is a quarter or half-past twelve. 20. It is a quarter to eight.

E. A. B.

GERMAN.—III

Strong Declension—Class 3.—To this class of nouns belong the greater number of neuter nouns of one syllable, and neuters ending in **tum**; further twelve masculines and about six neuters with the prefix **ge**.

They form their gen. sing. in **es** or **s** and the dat. sing. in **e**, like the nouns of the second class. They form the nom. plur. by adding the termination **er**, and all those capable of modification modify in the plur. The nouns ending in **tum** modify the **u** of this termination instead of the stem vowel.

Examples

	Sing.	*Plur.*
Nom.	das Haus (howss), *the house*	die Häus-**er** (hoyzər)
Gen.	des Haus-**es** (howzəs)	der Häus-**er**
Dat.	dem Haus-**e**	den Häus-**ern**
Acc.	das Haus	die Häus-**er**
Nom.	der Mann, *the man*	die Männ-**er** (mennər)
Gen.	des Mann-**es**	der Männ-**er**
Dat.	dem Mann-**e**	den Männ-**ern**
Acc.	den Mann	die Männ-**er**

The neut. noun das Fürstentum (fürstəntoom), *the principality*, has nom. plur. Fürstentümer (fürstəntümər).

The twelve mas. nouns that belong to this class are:

Bö'sewicht (bö'səvicht), *rogue.*
Geist (gyst), *spirit, intellect.*
Gott (got), *god.*
Irr'tum (irr'toom), *mistake.*
Leib (lyp), *abdomen.*
Mann, *man.*
Rand (rant), *edge.*
Reich'tum (rych'toom), *riches.*
Strauch (shtrowk), *bush.*
Vor'mund (fohr'munt), *guardian.*
Wald (valt), *forest.*
Wurm (voorm), *worm.*

Note that der Ort, *the place*, has two plurals, Orte, *places*, and Örter, *towns*.

Declension of the Personal Pronouns

	Sing.	*Plur.*
	1st pers.—	
Nom.	ich (ich), *I*	wir (veer), *we*
Gen.	meiner (mynər)	unser (unzər)
Dat.	mir (meer)	uns (unss)
Acc.	mich (mich)	uns
	2nd pers.—	
Nom.	du (doo), *thou*	ihr (eer), *ye, you*
Gen.	deiner (dynər)	eurer (oyrər)
Dat.	dir (deer)	euch (oych)
Acc.	dich (dich)	euch

Sing.

	3rd pers.— *Mas.*	*Fem.*
Nom.	er (ayr), *he*	sie (zee), *she*
Gen.	seiner (synər)	ihrer (eerər)
Dat.	ihm (eem)	ihr
Acc.	ihn (een)	sie
	Plur., all Genders	
Nom.	es (ess), *it*	sie, *they*
Gen.	seiner	ihrer
Dat.	ihm	ihnen (eenen)
Acc.	es	sie

The declension of the polite form of address **Sie**, *you*, is exactly the same as that of the third pers. plur. sie, except that it is written with a capital in all cases.

Note that the third pers. pron. agrees in gender with the noun to which it refers: Wo ist die Gabel? Sie ist hier. *Where is the fork? It is here.* Haben Sie Ihren Stock (shtock)? Ja, ich habe ihn. *Have you your stick? Yes, I have it.*

The **verb sagen** (zahgən), *to say.*

Present Indicative	*Preterite Indicative*
ich sag-**e** (zahgə), *I say, I am saying.*	ich sag-**te** (zahgtə), *I said, I was saying*
du sag-**st**, *thou sayest.*	du sag-**test**, *thou saidst.*
er sag-**t**, *he says.*	er sag-**te**, *he said.*
wir sag-**en**, *we say.*	wir sag-**ten**, *we said.*
ihr sag-**t**, Sie sag-**en**, *you say.*	ihr sag-**tet**, Sie sag-**ten**, *you said.*
sie sag-**en**, *they say.*	sie sag-**ten**, *they said.*

The verb is conjugated in the same way for the fem. and neut. prons. **sie** and **es**.

All so-called weak verbs are conjugated as the above, only those of which the stem ends in d or t, like reden (raydən), *to speak*, beten (baytən), *to pray*, usually take the fuller forms, **est** and **et** in the second pers. sing. and plur. respectively, e.g. du redest, ihr redet. The polite forms remain unchanged.

Negative and interrogative forms are as follows:—

Ich sage nicht. Sagt er? Sagen Sie nicht?
Sie sagten kein Wort. Sagten sie kein Wort?

The neg. **nicht** sometimes precedes and sometimes follows the direct object of a transitive verb, e.g. Er kauft nicht das Haus; or:—Er kauft das Haus nicht. The second form makes the negative more emphatic.

In interrogative sentences the verb is simply placed before the subject, whether the subject be a pronoun or a noun, e.g. Kauft der Mann das Haus? or:—Kauft er das Haus?

In negative interrogative sentences the negative nicht usually follows the object of the verb.

VOCABULARY

holen (hohlən), *to fetch.*
Gepäck'träger (gəpeck'-traygər), s.m.1, *porter.*
Buch (book), s.n.3, *book.*
kosten (kostən), *to cost.*
Mark (mark), f., *mark (a coin).*
Tisch (tish), s.m.2, *table.*
warum' (vahrum'), *why.*
zu (tsoo), *too* (adv.).
Diener (deenər), s.m.1, *manservant.*
Lärm (lerm), s.m.2, *noise.*
Stiefel (shteefəl), s.m.1, *boot.*
Strasze (shtrahssə), f., *street.*
weit (vyt), *far.*
artig (artig), *good, well behaved.*
Gepäck (gəpeck), s.n.1, *luggage.*
Brief (breef), s.m.2, *letter.*
Zeitung (tsytungk), f., *newspaper.*
vier (feer), *four.*
Hut (hoot), s.m.2, *hat.*
im = in dem, *in the.*
kommen (kommən), *to come.*
bringen (bringən), *to bring.*
hören (hörən), *to hear.*
suchen (zookən), *to seek, look for.*
Bahn'hof (bahn'hohf), s.m.2, *railway station.*
wohnen (vohnən), *to dwell, live.*
Deutsch'land (doytsh'-lant), *Germany.*

The abbreviations s.m.1 placed after nouns mean strong masculine Class 1, the numbers referring to the different declensions, and w placed after a noun will indicate that it belongs to the weak declension.

Several prepositions can be contracted with the dat. or acc. sing. of the def. art. mas. and neut. They are: **an** (an), *on, at,* **auf** (owf), *on, on to,* **bei** (by), *near,* **durch** (durch), *through,* **für** (für), *for,* **in**, *in, into,* **über** (übər), *over,* **um** (um), *round, about,* **von** (fon), *from, of,* **vor** (fohr), *before,* **zu**, *to, at.*

They contract as follows: am (an dem), ans (an das), aufs, beim, durchs, fürs, im, ins, übers, ums, vom, vors, zum (tsum).

One only contracts with the dat. fem. sing., namely, zur (tsoor) (zu der).

Unterhaltung

Was ſagten Sie mir? — Ich ſagte Ihnen nichts.
Holt der Mann unſer Gepäck? — Der Gepäckträger holt Ihr Gepäck.
Hatte ſie heute einen Brief? — Nein, aber ſie hatte geſtern drei Briefe.
Kauften die Männer Bücher? — Nein, ſie kauften eine Zeitung.
Was koſtet dieſes Buch? — Es koſtet vier Mark.
Wo iſt mein Hut? — Er iſt auf dem Tiſch.
Spielten die Kinder im Garten? — Nein, ſie waren zu Hauſe.
Warum kommt Ihre Frau nicht? — Sie iſt zu müde.
Bringt der Diener mir die Zeitung? — Sie iſt noch nicht hier.
Hören Sie einen Lärm? — Nein wir hören keinen Lärm.
Was ſuchte er? — Er ſuchte ſeinen Hut und ſeinen Stiefel.
Iſt der Bahnhof weit von hier? — Nein, er iſt in der X Straße.
Wo wohnt dieſer Mann? — Er wohnt nicht hier, er wohnt in Deutſchland.
Die Kinder dieſer Frau ſind ſehr artig.

Exercise 10

1. What did he say to you? 2. The porters are bringing our luggage. 3. What did your hat cost? 4. My wife bought two hats. 5. Where is the paper? 6. It is on the table. 7. Did the manservant fetch her luggage? 8. She had no luggage. 9. What do you hear? 10. I hear a noise. 11. What were you looking for? 12. We were looking for the children in the garden, but they were at home. 13. Where is the station? 14. It is in X Street. 15. Who lives here? 16. Why did you not fetch our luggage? 17. That man's books are not here.

Weak Declension.—To this declension belong all feminine nouns except the nouns of one syllable that belong to Class 2 of the strong declension and the two nouns (Mutter and Tochter) which belong to Class 1. A few monosyllabic fem. nouns also belong to the weak declension. This declension includes all mas. nouns ending in **e** and a few which do not end in **e**, or in which the **e** is optional.

All nouns of this declension form the nom. plur. by adding **en** or **n**. The mas. nouns add **n** in the oblique cases of the sing., but the fem. nouns remain unchanged.

Nouns ending in **e**, **el**, **er**, and **ar** add **n**; all others add **en**. Thus: die Blume (bloomə), *the flower,* plur. die Blumen; die Fabel (fahbəl), *the fable,* plur. die Fabeln; but die Tat (taht), *the dead,* plur. die Taten.

No noun of this declension modifies in the plur. The student must remember that one mas. noun in e, i.e. Käse, belongs to the strong declension, class 1. No neuter noun follows the weak declension.

Examples

	Sing.	*Plur.*
Nom.	die Tante (tantə), *the aunt*	die Tante-**n**
Gen.	der Tante	der Tante-**n**
Dat.	der Tante	den Tante-**n**
Acc.	die Tante	die Tante-**n**
Nom.	die Schwester (shvestər), *sister*	die Schwester-**n**
Gen.	der Schwester	der Schwester-**n**
Dat.	der Schwester	den Schwester-**n**
Acc.	die Schwester	die Schwester-**n**
Nom.	der Mensch (mensh), *man, human being*	die Mensch-**en**
Gen.	des Mensch-**en**	der-Mensch-**en**
Dat.	dem Mensch-**en**	den-Mensch-**en**
Acc.	den Mensch-**en**	die Mensch-**en**

The mas. Herr (hayrr), *sir, gentleman,* adds **n** in the sing. and **en** in the plur.

The commonest mas. nouns not ending in **e** which belong to this declension are :—

Bär (bayr), *bear.*
Christ (krist), *Christian.*
Fürst (fürst), *prince.*
Fink(e) (fink(ə)), *finch.*
Geck (geck), *fop.*
Gesell(e) (gəzell(ə)), *fellow.*
Graf (grahf), *count.*
Held (helt), *hero.*
Hirt(e) (hirt(e)), *shepherd.*
Mohr (mohr), *moor.*
Pfau (pfow), *peacock.*
Prinz (prints), *prince.*
Schenk (shenk), *cupbearer.*
Spatz (shpats), *sparrow.*
Sprosz (shpross), *sprig.*
Tor (tohr), *fool.*
Vor'fahr (fohr'fahr), *ancestor.*

VOCABULARY

König (könig), s.m.2, *king.*
un'zufrieden (un'tsoofreedən), *dissatisfied.*
Eremit' (eraymeet'), w.m., *hermit.*
glücklich (glücklich), *happy.*
werden (vayrdən), *to become.*
du muszt (musst), *thou must.*
tragen (traghən), *carry, wear.*
du sollst (zolst), *thou shalt.*
ich will (vill), *I will.*
du bist (bist), *thou art.*
er sah (zah), *he saw.*
alt (alt), *old.*
er ging (gingk), *he went.*
fragen (frahgən), *to ask.*
ich kann (kan), *I can.*
ant'worten (ant'vortən), *to answer.*
Hemd (hemt), s.n.2, *shirt.*
Minis'ter (minis'ter), s.m.1, *minister.*
finden (findən), *to find.*
Stadt (shtat), s.f.2, *town.*
Land (lant), s.n.3, *land, country.*
gib (geep), imperat., *give.*

Exercise 11

ERZÄHLUNG

Es war einmal ein König. Er war alt und unzufrieden. Er ging zu einem Eremiten und fragte ihn: „Wie kann ich glücklich werden?" Der Eremit antwortete, „Du mußt das Hemd eines glücklichen Menschen tragen!" Der König sagte darauf zu seinem Minister „Du sollst einen glücklichen Menschen finden,[1] und ich will dann sein Hemd tragen!" Der Minister ging in die Stadt, und er fragte jeden Menschen, „Bist du glücklich?" Aber jeder Mann antwortete, „Nein." Er ging dann aufs Land und sah dort einen Hirten. Er fragte ihn „Bist du glücklich?" Der Hirte antwortete „Ja, warum nicht?" Der Minister brachte den Hirten zu dem König. Dieser sagte ihm, „Gib mir dein Hemd." Der Hirte antwortete aber darauf, „Ich habe kein Hemd."

NOTE :—

1. In German, infinitives and past participles dependent on other verbs are placed at the end of the sentence. Thus: du mußt tragen, *thou must wear,* but du mußt das Hemd eines glücklichen Menschen tragen, *thou must the shirt of a happy man wear.*

Exercise 12

Reply in German to the following questions :

1. Wie war der König? 2. Was tat er? 3. Was sagte der König? 4. Was antwortete der Eremit? 5. Was tat der Minister? 6. Wer war glücklich? 7. Wer brachte den Hirten zu dem König? 8. Hatte der Hirte ein Hemd?

Key to Exercise 3

1. Had I? 2. We have not. 3. Has it not? 4. You have not. 5. She has. 6. She had not. 7. You had not. 8. Have they? 9. Have you? 10. Haben wir? 11. Hatten Sie nicht? 12. Sie haben nicht. 13. Sie hat. 14. Es hatte. 15. Wir hatten nicht. 16. Haben Sie? 17. Er hat nicht.

Key to Exercise 4

1. The father is a man, and the mother is a woman. 2. Who is this man? He is the uncle of that woman. 3. What has the child? He has a spade. 4. Where are the pupils? They are in the garden. 5. The weather was fine yesterday; it is bad today. 6. The pupil of this teacher is good. 7. Where were the gardeners? They were downstairs. 8. I give the brother a spade. 9. The uncle is in a monastery. 10. Who are those girls? They are the daughters of this woman. 11. (The) Life in the mountains is beautiful. 12. This girl has a father, a mother, and a brother.

Key to Exercise 5

1. Wer ist jenes Kind? Es ist die Tochter dieser Frau. 2. Wo ist der Gärtner? Er ist oben. 3. Dieser Mann ist der Lehrer jener Schüler. 4. Das Gebirge ist dort. 5. Die Brüder jener Frau sind in einem Kloster. 6. Ist das Wetter heute schön? 7. Der Vater war hier aber die Mutter war nie hier. 8. Jener Mann hatte Gärtner. 9. Diese Mädchen haben einen Onkel. 10. Er ist der Bruder jener Mädchen. 11. Hatten Sie einen Spaten? 12. Wir waren in dem Garten.

Key to Exercise 6

There was once a man. He had a wife and two daughters. The wife was beautiful, the man was big, but he was not beautiful. The daughters were small and pretty. The man was a gardener and had a garden. In the garden were apples, and vegetables and also a lawn. On the lawn were birds; these birds were small. The man worked in the garden, and his wife and daughters played there.

Key to Exercise 7

Seine Frau war schön. Seine Töchter waren klein und hübsch. Der Mann war Gärtner. Äpfel und Gemüse waren in dem Garten. Vögel waren auf dem Rasen. Die Vögel waren klein. Der Mann war in seinem Garten. Seine Frau und seine Töchter waren auch da.

Key to Exercise 8

A man came after the battle of Actium and congratulated the Emperor; the man had a crow, and the bird said, "Hail, Emperor and Conqueror." The Emperor admired the bird and bought it. He also bought a parrot and a magpie, for these birds also said the greeting. A cobbler lived at that time in Rome; the cobbler was poor, and he taught the greeting to a crow. The cobbler's crow learnt slowly, and the cobbler often became tired, and then he said, "My time and my trouble are lost." But at last the crow learnt the words, and the man brought it to the Emperor. But the latter said, "I have three birds at home, they also say these words." Thereupon the crow said, "My time and my trouble are lost," and the Emperor laughed heartily and took the bird, and gave the cobbler much money.

M. A. L.

Continued from page 300

GEOGRAPHY:

Contributors:—**Robert Finch, F.R.G.S.; W. H. Koebel; Sir John Scott-Keltie, LL.D.; Cyril J. Silverston, B.Sc.(Lond.).**

THE MAKING OF THE EARTH

It has been well said that "Geology is the Geography of the Past." In order to understand the geography of the present, we must look constantly back to the geography of the past.

A knowledge of the simple geology of a region enables us to understand:

(1) The distribution and character of Land Forms, which are the visible results of the action of wind and weather, heat and cold, snow and ice upon the rocks. Rocks "weather" in accordance with their characteristic structure—a matter of geology. The rounded outlines of a chalk "down," the rugged pinnacles and turrets of the Peak district and other limestone regions, and the water-logged flats of the Fens—all become intelligible by the study of Geology.

Soil, Minerals, Town-sites

(2) The distribution of Soils. The disintegration of the rocks by natural forces results in soil. Though the soil above any rock is not necessarily derived from that rock (since soils may be and are often transported long distances by wind, ice, or running water), yet geology often explains why some areas are wooded, others not; why some regions are cultivated and others desert. More than this, it may help us to infer, or explain, the characteristic crops or the indigenous vegetation. The Surrey pinewoods flourish on the thin iron-rich sands of the Bagshot series; the beech woods of Buckinghamshire are characteristic of the chalk.

(3) The distribution of mineral wealth. Certain rocks yield certain minerals. Coal occurs chiefly in the well-known carboniferous series, though in America coal of Secondary and even of Tertiary age is worked. The valuable ore deposits occur usually in the older and harder igneous rocks, especially in areas where the rocks have undergone much crumpling, folding, and fracturing.

(4) Distribution of population and sites of towns. The presence of coal and iron—the two essentials of modern manufacturing—means the concentration of population in that area, and the growth of huge industrial towns at points where favourable conditions of transport or of labour are existent.

Thus many of the physical and economic phenomena of any region are ultimately referable to geology. The reader will do well to refer constantly to the Geology lessons in this work, in relation to his study of Geography.

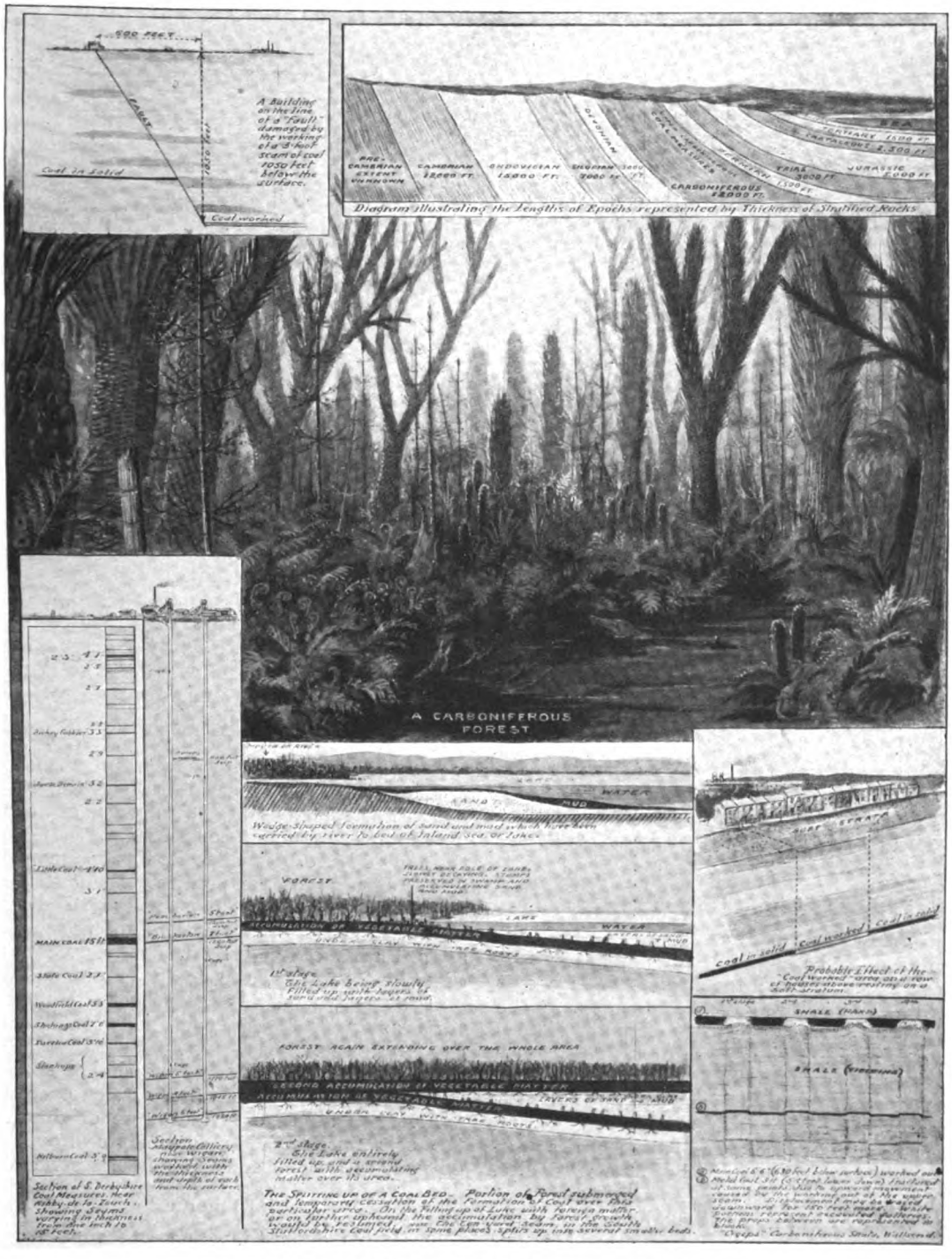
The earliest rocks that can be traced were Igneous rocks—those which had cooled from a molten state to form the first earth crust. What this first crust was like we have no true notion. It must have been repeatedly and spasmodically subjected to great rendings and fracturings, especially at first, when the cooling contracting crust became, as it were, too tight to confine the still molten interior.

When eventually this crust attained some degree of rigidity and stability, it became subject to the disintegrating influences of wind, rain, running water, and other giant forces which have done so much to mould and carve the surface of the earth. The fragments of the first igneous rocks, worn away by elemental forces and transported to lower levels or to the sea by running water, glaciers, avalanches, and the like, were deposited in layer-like beds to form the strata of the first aqueous rocks.

Types of Rocks

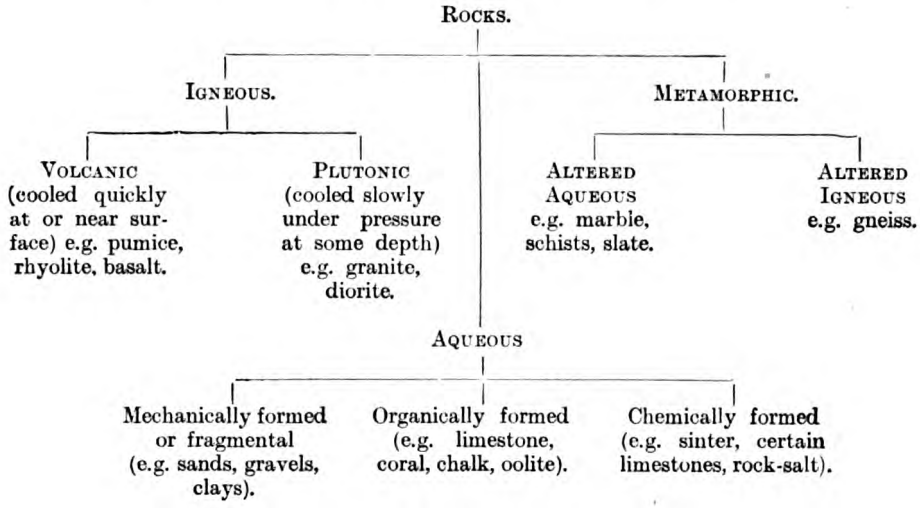
Since those days, both aqueous and igneous rocks have been in course of formation, while others both aqueous and igneous have been reduced to fragments under the forces of denudation. Rocks above sea-level are gradually being worn down; those being deposited below the surface of the sea may in time be elevated to form new land, as others have been before them.

The chief kinds of rocks are conveniently summarised in the table which is to be found on p. 364.



NATURE AND MAN AS COAL PROVIDERS.

Coal areas were once submerged beneath fathoms of ocean, whence the limestone was formed (1st stage). The sea gradually shallowed, and gritty sandstone was formed above the limestone from the deposits of land debris (2nd stage). Slowly the dry land emerged, and upon it was soon established a rank growth of dense vegetation (3rd stage). Floods or changes in level submerged the coal forests, the remains of which, excluded from light and air, became carbonised and solid, forming coal seams.



All these are in course of formation to-day: igneous rocks in volcanic regions where eruptions spread sheets of lava and ashes over the old land surfaces; aqueous rocks in every sea and lake bed, and in the lower courses of every large river; metamorphic rocks at depths where the pressure is enormous, and in places where molten volcanic rock comes in contact with pre-existent rock-material. They are at once the causes and the results of the simultaneous destruction and construction which have gone on since the earth's beginning, and which must go on until the end of terrestrial time.

Certain types of aqueous rocks may here be selected for special study.

Chalk Downs

Under microscopic examination chalk will be seen to be composed of a multitude of tiny shells pressed together to form a soft white friable limestone. Embedded in the mass are fossil shell-fish—sea-urchins, lamp-shells, and the like. The obvious inference is that our chalk "downs" are made of material which once formed the ooze of the ocean-bed, and which by crustal elevation has been raised to form the hills of south-east England. From the bed of the Atlantic, fathoms deep, hydrographers have dredged up a grey ooze much like what chalk must have been before it became solid under enormous pressure. In the Cretaceous Period —some ten million years ago—the southern half of prehistoric Europe was submerged beneath a subtropical sea, in which swarmed the myriads of tiny foraminifera whose living shells sunk to the ocean floor to build up the great beds of chalk which stretch from Britain to South Russia. At the close of the Cretaceous Period, slow crustal movement elevated the chalk beds to form part of the continental area, and threw them into great folds.

Some limestones are masses of large shells or of living encrinites or "stone-lilies"—starfishes that grew on a many-jointed stem and were rooted to the sea-floor. The limestones of the Coal Measures suggest that hundreds of square miles of prehistoric sea-bed must have been thickly covered with these encrinites.

A careful examination of the great clay-beds which underlie the streets of the northern suburbs of London, reveals that they must have been deposited as sediments in the estuary of the prehistoric Thames—an estuary which began at where Reading now is, and included the whole of the gulf-shaped area covered by the clay. Fossils of palm-tree nuts, the teeth of crocodiles and sharks, and the carapaces of huge turtles suggest climatic conditions far different from those of to-day.

Clay under pressure becomes shale; shale under pressure becomes a schist, or even a slate. The slates of Wales were originally the soft finely divided sediments brought down ages ago by some prehistoric river.

Coal Measures

A simple example which one may take from the Carboniferous System will serve to show how the past history of the earth is written in the rocks. This system is highly important; it includes the coal seams which mean wealth and economic development to-day. It includes three great series: (*a*) the Carboniferous Limestone; (*b*) the Millstone Grit; (*c*) the Coal Measures.

The Carboniferous Limestone, some 20,000 feet probable maximum thickness, is a mass of fossils of organisms that swam in the sea or crawled or grew on the sea bed.

The Millstone Grit is a layer of gritty sands such as one finds on a sea shore, or such as large rivers might bring down.

The Coal Measures consist of alternate layers of sandstone, clay, coal, and ironstone. Above the coal is the sandstone bed known to miners as "roof of the coal"; below the coal is the so-called "underclay" in which are frequently found the fossil roots of the trees whose trunks and leaves went to form the coal itself.

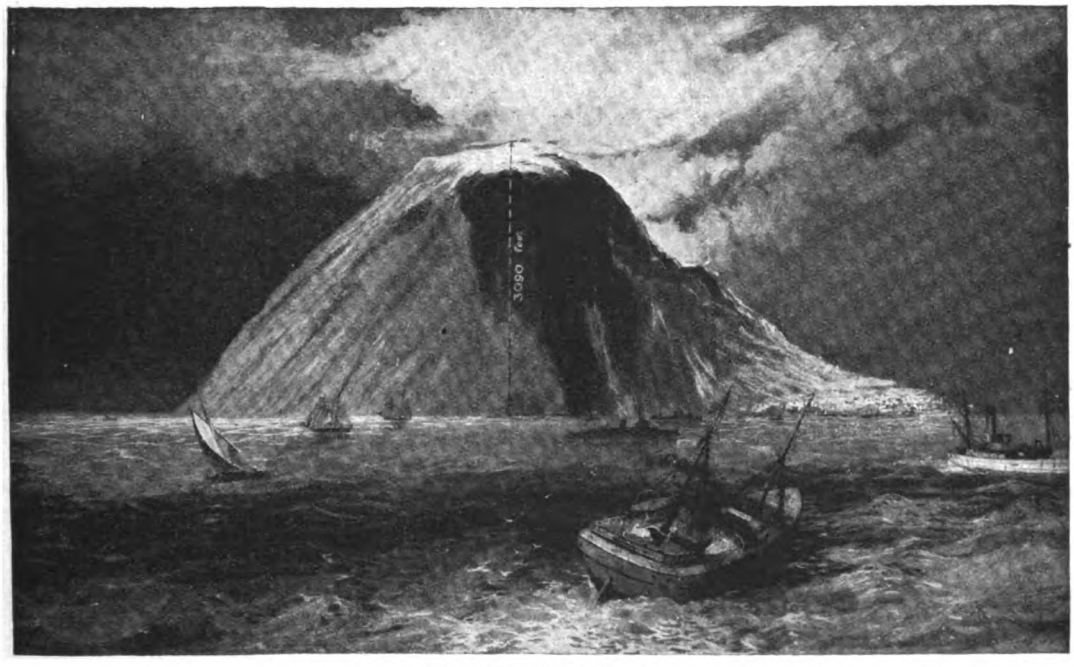
Let us briefly interpret the story told by these rocks. The areas where coal is now mined must once have been submerged beneath fathoms of ocean, or the limestone could not have been formed. This sea gradually shallowed, for above the limestone is the gritty sandstone formed from the deposits of land debris brought down by great rivers. Slowly the dry land emerged, and upon it there soon became established a rank growth of dense vegetation. In the forests of huge tree-ferns and sigillaria, and the dense jungle of calamites and club-mosses, lived the giant reptiles whose remains are occasionally found in the coal seams.

Great floods, or perhaps actual changes in level, submerged the coal forests, and led to the deposit of sandstone above the seam of coal—for with the exclusion of light and air and under the enormous pressure, the remains of the forests became carbonised and solid. We frequently find coal seams in series, one above another and separated by sandstones and clays. This suggests that the floods, or the subsidences, caused submergences to follow successive elevations of the land.

Lignite, the brown coal common in Belgium and Germany, appears to be imperfectly formed coal. Peat suggests another intermediate stage.

The geological accidents which made the Carboniferous System what it is, lie at the root of Britain's economic greatness. Coal, the source of light, warmth, and power, occurs with iron in the sandstone layers, with clay for moulds, and with limestone for fluxes—a combination of "raw materials" which is responsible not only for our great iron and steel industries, but ultimately for the establishment of Britain's chief industries.

Geology shows that the surface of the earth has derived its broad differentiations of relief, and some of its minor ones, from movements of the crust. There are two types, (*a*) gradual and often imperceptible; (*b*) cataclysmic and sudden.



STROMBOLI IN ERUPTION.

Volcanic eruptions are cataclysmic examples of the crustal movements which shape the earth's surface.

On the tops of high mountains one meets with strata thickly studded with marine shells, or sometimes wholly composed of prehistoric sea-corals and stone-lilies (encrinites). The Rigi, near Lucerne, is largely composed of a conglomerate which must have been deposited in an old lake-bed or in an ancient sea. All these are evidences that there has been in times past some great uplift of sub-aqueous strata, which has become not merely dry land, but mountain ranges and peaks. Such changes were most probably slow and almost imperceptible.

Slow Crustal Movements

Of the sudden, catastrophic changes in the earth's crust we have constant and often terrible examples. The eruption of Mont Pelée in Martinique in 1902, and the terrible earthquake of 1908, which crumpled up the north-east corner of Sicily and made a dust-heap of Messina, are examples.

In the Alps and in every region where considerable rock-sections are exposed, the strata are seen to be wonderfully contorted. It is as if some giant had seized them in a plastic condition and had crumpled them by pressing suddenly sideways. Often the strata have suffered worse; giant fractures, or "faults," occur in many places; and often the strata have slipped down along one side of the fault, leaving the other side *in situ*.

Where folding and faulting have occurred on a very large scale, mountains have resulted. Fold ranges like those of the Atlas and the Andes, and crust-blocks or block-mountains like those of the Western Cordillera of the U.S.A. are examples.

Foldings and Faultings

All these foldings and faultings are directly the effects of changes in the earth's interior—changes which have exerted tremendous lateral pressure at various places in the earth-crust. There came a stage in the life of the earth-crust when the rigid crust was, as it were, too big for the cooling and contracting interior. Under the giant energy of gravitational force the outer crust was pressed, squeezed, folded, and crumpled in to fit—not in one or a series of cataclysms, but, as a rule, slowly and almost simultaneously with the internal shrinkage.

The estuary of the Forth and the Humber in Britain, of the Chesapeake and the Hudson in the United States, are the drowned ends of river valleys. They are the effects of a slow and general coastal submergence.

Again, marks once made at sea-level on Swedish cliffs are now many feet above water—indicating crustal elevation. R. F.

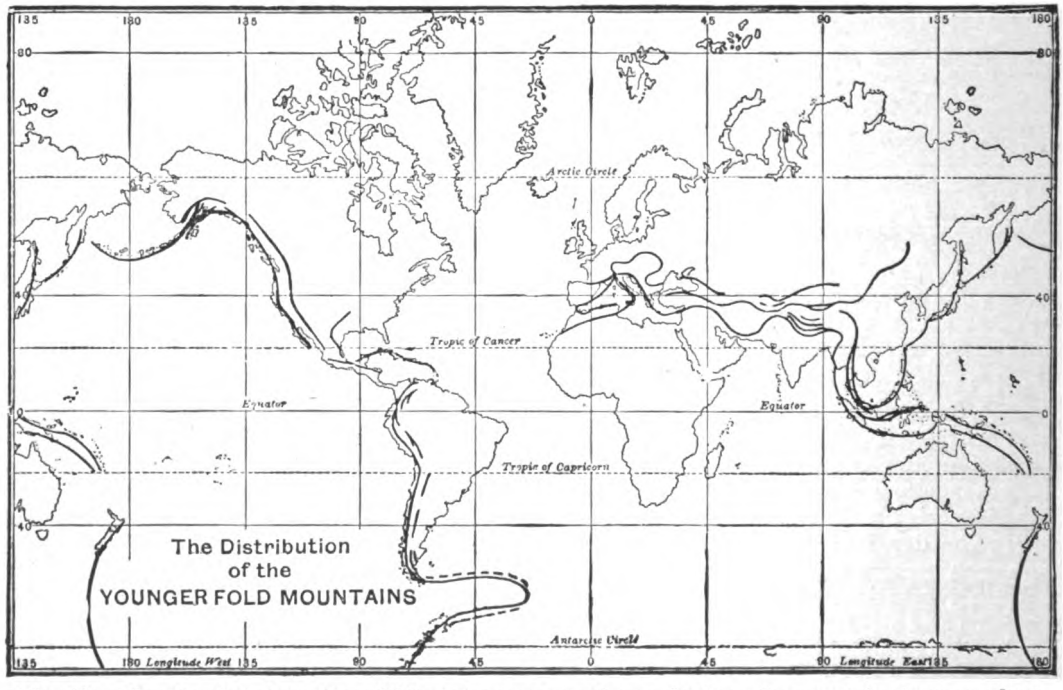


Fig. 20.—Map showing that where foldings have occurred on a large scale mountains have resulted, e.g. the fold ranges of the Andes and crust-blocks of the Western Cordillera, U.S.A.

Continued from page 313.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—VI

59. When we have a number of fractions with different denominators, it is often necessary to reduce them to equivalent fractions all having the same denominator.

Consider the fractions $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$, $\frac{5}{6}$. To reduce these to a common denominator, we may select as denominator any number that is a common multiple of each of the given denominators. Let us take in this case 1080. Consider the fraction $\frac{2}{3}$. The denominator 3 is to become 1080, ∴ it must be multiplied by $1080 \div 3$, i.e. 360.

∴ the numerator must also be multiplied by 360, otherwise the value of the fraction will be altered.

$$\frac{2}{3} = \frac{2 \times 360}{3 \times 360} = \frac{720}{1080}.$$

Next consider $\frac{3}{4}$. The numerator and denominator must both be multiplied by $1080 \div 4$, i.e. 270.

$$\frac{3}{4} = \frac{3 \times 270}{4 \times 270} = \frac{810}{1080}.$$

Similarly $\frac{4}{5} = \frac{4 \times 216}{5 \times 216} = \frac{864}{1080}$.

And $\frac{5}{6} = \frac{5 \times 180}{6 \times 180} = \frac{900}{1080}$.

Thus, the equivalent fractions are $\frac{720}{1080}$, $\frac{810}{1080}$, $\frac{864}{1080}$ and $\frac{900}{1080}$ respectively.

However, it is generally desirable that the common denominator should be the least possible. This is the L.C.M. of all the denominators and is called the Lowest Common Denominator.

Reduce $\frac{2}{3}$, $\frac{3}{4}$, $\frac{4}{5}$ and $\frac{5}{6}$ to their lowest common denominator.

The L.C.M. of the denominators 3, 4, 5, 6 is 60.

$$\frac{2}{3} = \frac{2 \times 20}{3 \times 20} = \frac{40}{60} \qquad \frac{3}{4} = \frac{3 \times 15}{4 \times 15} = \frac{45}{60}$$

$$\frac{4}{5} = \frac{4 \times 12}{5 \times 12} = \frac{48}{60} \qquad \frac{5}{6} = \frac{5 \times 10}{6 \times 10} = \frac{50}{60}$$

Thus, the equivalent fractions are $\frac{40}{60}$, $\frac{45}{60}$, $\frac{48}{60}$ and $\frac{50}{60}$.

Reduce $\frac{24}{56}$, $\frac{26}{28}$ and $\frac{15}{36}$ to their lowest common denominator.

First we must reduce the fractions to their lowest terms.

$$\frac{24}{56} = \frac{3}{7}, \qquad \frac{26}{28} = \frac{13}{14}, \qquad \frac{15}{36} = \frac{5}{12}.$$

The L.C.M. of 7, 14 and 12 = 84.

$$\frac{24}{56} = \frac{3}{7} = \frac{3 \times 12}{7 \times 12} = \frac{36}{84}, \quad \frac{26}{28} = \frac{13}{14} = \frac{13 \times 6}{14 \times 6} = \frac{78}{84}$$

$$\frac{15}{36} = \frac{5}{12} = \frac{5 \times 7}{12 \times 7} = \frac{35}{84}.$$

Thus, the equivalent fractions are $\frac{36}{84}$, $\frac{78}{84}$, $\frac{35}{84}$.

60. When there are two or more fractions having the same denominator, it is clear that the fraction with the greatest numerator is the fraction of greatest magnitude. For in each case the unit is divided into the same number of equal parts, and the numerator shows how many of these parts are taken.

Therefore, if we wish to compare the magnitudes of a number of fractions, we must reduce them to their lowest common denominator.

Compare the magnitude of $\frac{5}{12}$, $\frac{3}{16}$, $\frac{10}{21}$ and $\frac{31}{60}$ and arrange them in ascending order.

The L.C.M. of 12, 16, 21 and 60 is 1680.

$$\frac{5}{12} = \frac{5 \times 140}{12 \times 140} = \frac{700}{1680}, \quad \frac{3}{16} = \frac{3 \times 105}{16 \times 105} = \frac{315}{1680},$$

$$\frac{10}{21} = \frac{10 \times 80}{21 \times 80} = \frac{800}{1680}, \quad \frac{31}{60} = \frac{31 \times 28}{60 \times 28} = \frac{868}{1680}.$$

Therefore, the fractions arranged in ascending order of magnitude are, $\frac{3}{16}$, $\frac{5}{12}$, $\frac{10}{21}$, $\frac{31}{60}$.

Exercise 16

Reduce to their lowest common denominator.

(1) $\frac{5}{6}$, $\frac{3}{14}$, $\frac{11}{15}$, $\frac{19}{24}$. (2) $\frac{4}{5}$, $\frac{9}{16}$, $\frac{16}{25}$, $\frac{25}{36}$, $\frac{36}{49}$.
(3) $\frac{7}{12}$, $\frac{3}{16}$, $\frac{9}{28}$, $\frac{17}{84}$. (4) $\frac{9}{10}$, $\frac{99}{100}$, $\frac{999}{1000}$, $\frac{9999}{10000}$.
(5) $\frac{31}{35}$, $\frac{37}{55}$, $\frac{41}{45}$, $\frac{23}{105}$, $\frac{2}{5}$, $\frac{4}{7}$.
(6) $\frac{23}{24}$, $\frac{91}{105}$, $\frac{17}{21}$, $\frac{3}{42}$, $\frac{5}{8}$, $\frac{19}{72}$.

Compare and arrange in descending order of magnitude:

(7) $\frac{8}{15}$, $\frac{23}{45}$, $\frac{26}{75}$. (8) $\frac{6}{7}$, $\frac{7}{12}$, $\frac{17}{28}$, $\frac{19}{21}$, $\frac{35}{36}$.
(9) $\frac{3}{40}$, $\frac{7}{12}$, $\frac{9}{24}$, $\frac{37}{72}$. (10) $\frac{9}{16}$, $\frac{17}{24}$, $\frac{29}{36}$, $\frac{9}{16}$, $\frac{41}{48}$.

61. Addition of Fractions.—When two or more fractions have the same denominator they may be added by finding the sum of their numerators. This will then be the new numerator and the original denominator will be retained.

Consider $\frac{2}{7} + \frac{3}{7}$.

Just as 2 shillings + 3 shillings make 5 shillings,
so 2 sevenths + 3 sevenths make 5 sevenths,

$$\text{or } \frac{2}{7} + \frac{3}{7} = \frac{2+3}{7} = \frac{5}{7}.$$

When the fractions to be added have different denominators they must first be reduced to their lowest common denominator and then added.

Examples:

(1) Find the sum of $\frac{5}{6} + \frac{2}{9} + \frac{7}{12}$.
The L.C.M. of 6, 9 and 12 is 36.

$$\frac{5}{6} + \frac{2}{9} + \frac{7}{12} = \frac{5 \times 6}{6 \times 6} + \frac{2 \times 4}{9 \times 4} + \frac{7 \times 3}{12 \times 3}$$
$$= \frac{30}{36} + \frac{8}{36} + \frac{21}{36} = \frac{30 + 8 + 21}{36} = \frac{59}{36} = \mathbf{1\frac{23}{36}}.$$

All fractions should be reduced to their lowest terms, before they are reduced to their lowest common denominator.

Further, if the sum of a number of fractions be a fraction which is not in its lowest terms, this should be reduced to its lowest terms.

Before adding, all improper fractions should be reduced to mixed numbers; the integers may then be added together as in simple addition, and then the fractional parts should be added. If the sum of the fractional parts be an improper fraction, this also should be reduced to a mixed number, and the integer should be added to the sum of the other integers.

(2) Find the sum of $\frac{2}{3} + \frac{6}{8} + 2\frac{4}{9} + 1\frac{10}{12} + \frac{31}{6}$.

$$\frac{2}{3} + \frac{6}{8} + 2\frac{4}{9} + 1\frac{10}{12} + \frac{31}{6} = \frac{2}{3} + \frac{3}{4} + 2\frac{4}{9} + 1\frac{5}{6} + 5\frac{1}{6}$$
$$= 2 + 1 + 5 + \frac{2}{3} + \frac{3}{4} + \frac{4}{9} + \frac{5}{6} + \frac{1}{6}$$
$$= 8 + \frac{2}{3} + \frac{3}{4} + \frac{4}{9} + \frac{5}{6} + \frac{1}{6}.$$

Now find the L.C.M. of the denominators. This is 36.

$$\frac{2}{3} + \frac{3}{4} + \frac{4}{9} + \frac{5}{6} + \frac{1}{6} = \frac{24 + 27 + 16 + 30 + 6}{36}$$
$$= \frac{103}{36} = \mathbf{2\frac{31}{36}}.$$ (The intermediate steps can be supplied by the student.)

$$\therefore 8 + \frac{2}{3} + \frac{3}{4} + \frac{4}{9} + \frac{5}{6} + \frac{1}{6} = 8 + 2\frac{31}{36}$$
$$= 8 + 2 + \frac{31}{36} = \mathbf{10\frac{31}{36}}.$$

It is often easier to add the fractions in groups, as much of the work can then be done mentally. In the above example, for instance, we can see at once that $\frac{5}{6} + \frac{1}{6} = 1$, and also $\frac{2}{3} + \frac{4}{9} = \frac{10}{9} = 1\frac{1}{9}$.

$$\therefore 8 + \frac{2}{3} + \frac{3}{4} + \frac{4}{9} + \frac{5}{6} + \frac{1}{6} = 8 + 1 + 1\frac{1}{9} + \frac{3}{4}$$
$$= 10 + \frac{1}{9} + \frac{3}{4} = \mathbf{10\frac{31}{36}}.$$

(3) Find the sum of $\frac{4}{9} + \frac{1}{15} + \frac{3}{20} + \frac{7}{12}$.

$$\frac{4}{9} + \frac{1}{15} + \frac{3}{20} + \frac{7}{12}$$
$$= \frac{4 \times 4 \times 5 + 4 \times 3 + 3 \times 9 + 7 \times 3 \times 5}{2^2 \times 3^2 \times 5}$$
$$= \frac{80 + 12 + 27 + 105}{2^2 \times 3^2 \times 5} = \frac{224}{2^2 \times 3^2 \times 5} = \frac{2^2 \times 56}{2^2 \times 3^2 \times 5}$$
$$= \frac{56}{45} = 1\frac{11}{45}.$$

Exercise 17

Find the sum of the following fractions:

(1) $\frac{1}{4} + \frac{3}{4}$. (2) $\frac{1}{8} + \frac{5}{8}$. (3) $\frac{1}{8} + \frac{3}{8}$. (4) $\frac{1}{12} + \frac{5}{12} + \frac{7}{12} + \frac{11}{12}$. (5) $\frac{3}{17} + \frac{4}{17} + \frac{5}{17} + \frac{6}{17} + \frac{7}{17}$. (6) $\frac{3}{56} + \frac{9}{56} + \frac{11}{56} + \frac{13}{56}$. (7) $1\frac{1}{2} + \frac{2}{3}$. (8) $2\frac{3}{8} + 4\frac{1}{12}$. (9) $\frac{1}{15} + 2\frac{2}{15} + \frac{3}{4} + 5\frac{1}{3}$. (10) $\frac{5}{8} + 15\frac{1}{2} + 49\frac{17}{32} + \frac{5}{256}$. (11) $\frac{5}{8} + \frac{3}{9} + \frac{3}{12} + \frac{4}{13}$. (12) $12\frac{1}{7} + 2\frac{3}{28} + 1\frac{1}{16} + \frac{3}{4} + 9\frac{1}{224}$. (13) $10\frac{191}{312} + 11\frac{98}{429} + 7\frac{255}{512}$. (14) $51\frac{39}{323} + 16\frac{1001}{3876} + 20\frac{405}{2261} + 105\frac{1}{130}$.

62. Subtraction of Fractions.—When two fractions have the same denominator their difference may be found by finding the difference of their numerators. This will then be the new numerator and the original denominator will be retained.

Consider $\frac{4}{7} - \frac{2}{7}$.

Just as 4 shillings − 2 shillings = 2 shillings,
so 4 sevenths − 2 sevenths = 2 sevenths,

$$\text{or } \frac{4}{7} - \frac{2}{7} = \frac{2}{7}.$$

If the fractions have different denominators they must first be reduced to their lowest common denominator.

As in addition, all fractions should first be reduced to their lowest terms and all improper fractions to mixed numbers.

Examples:

(1) $\frac{3}{4} - \frac{5}{18}$.

The L.C.M. of 4 and 18 is 36.

$$\frac{3}{4} - \frac{5}{18} = \frac{3 \times 9}{4 \times 9} - \frac{5 \times 2}{18 \times 2} = \frac{27}{36} - \frac{10}{36} = \frac{27 - 10}{36}$$
$$= \mathbf{\frac{17}{36}}.$$

(2) $5\frac{5}{9} - 3\frac{3}{10}$.

The L.C.M. of 9 and 10 is 90.

$$5\frac{5}{9} - 3\frac{3}{10} = 5\frac{50}{90} - 3\frac{27}{90} = (5 - 3) + \left(\frac{50}{90} - \frac{27}{90}\right)$$
$$= 2 + \frac{50 - 27}{90} = 2 + \frac{23}{90} = \mathbf{2\frac{23}{90}}.$$

(3) $5\frac{1}{4} - 2\frac{5}{6}$.

The L.C.M. of 4 and 6 = 12.

$$5\frac{1}{4} - 2\frac{5}{6} = 5\frac{3}{12} - 2\frac{10}{12} = (5 - 2) + \left(\frac{3}{12} - \frac{10}{12}\right)$$
$$= 3 + \left(\frac{3}{12} - \frac{10}{12}\right).$$

Now we cannot subtract $\frac{10}{12}$ from $\frac{3}{12}$, as the former is the greater of the two. We therefore take 1 unit away from the 3 and add it to the smaller fraction.

$$3 + \left(\frac{3}{12} - \frac{10}{12}\right) = 2 + 1 + \left(\frac{3}{12} - \frac{10}{12}\right)$$
$$= 2 + \left(1\tfrac{3}{12} - \frac{10}{12}\right)$$
$$= 2 + \left(\frac{15}{12} - \frac{10}{12}\right) \quad \text{since } 1\tfrac{3}{12} = \frac{15}{12}.$$
$$2 + \left(\frac{15}{12} - \frac{10}{12}\right) = 2 + \frac{15 - 10}{12} = 2 + \frac{5}{12} = \mathbf{2\tfrac{5}{12}}.$$

(4) Simplify $12\tfrac{5}{42} - 10 + 7\tfrac{10}{21} - \frac{4}{9} - 5\tfrac{27}{35}$.

Taking the whole numbers first, we have:

$12 - 10 + 7 - 5 = 4$.

The L.C.M. of 42, 21, 9 and 35 is 630.

$$12\tfrac{5}{42} - 10 + 7\tfrac{10}{21} - \frac{4}{9} - 5\tfrac{27}{35}$$
$$= 4 + \frac{5 \times 15}{42 \times 15} + \frac{10 \times 30}{21 \times 30} - \frac{4 \times 70}{9 \times 70} - \frac{27 \times 18}{35 \times 18}$$
$$= 4 + \frac{75 + 300 - 280 - 486}{630}$$
$$= 4 + \frac{375 - 280 - 486}{630} = 4 + \frac{95 - 486}{630}$$
$$= 3 + 1 + \frac{95 - 486}{630} = 3 + \frac{630}{630} + \frac{95 - 486}{630}$$
$$= 3 + \frac{630 + 95 - 486}{630} = 3 + \frac{725 - 486}{630}$$
$$= 3 + \frac{239}{630} = \mathbf{3\tfrac{239}{630}}.$$

It is, of course, unnecessary to write out the working in so much detail, but the student is warned never to be too brief, and never to crowd his work into a small space, for both these proceedings are liable to lead to inaccuracy and mistakes. We give one more example more briefly worked:

(5) Simplify $7\tfrac{5}{6} - 5\tfrac{5}{8} + 19 - \frac{7}{12} - 8\tfrac{1}{3} - \frac{9}{20}$.

$$7\tfrac{5}{6} - 5\tfrac{5}{8} + 19 - \frac{7}{12} - 8\tfrac{1}{3} - \frac{9}{20}$$
$$= 13\ \frac{100 - 75 - 70 - 40 - 54}{120}$$
$$= 13\ \frac{100 - 239}{120}$$
$$= 11\ \frac{340 - 239}{120}$$
$$= \mathbf{11\tfrac{1}{120}}$$

(We must split 13 into 11 + 2 and express 2 as $\frac{240}{120}$, ∵ if we split it into 12 + 1 and express 1 as $\frac{120}{120}$ we get $\frac{220 - 239}{120}$ and we cannot subtract 239 from 220.)

(5a) Another method of working the same:

$$7\tfrac{5}{6} - 5\tfrac{5}{8} + 19 - \frac{7}{12} - 8\tfrac{1}{3} - \frac{9}{20}$$
$$= 13\ \frac{100 - 75 - 70 - 40 - 54}{120}$$
$$= 13 + \frac{100}{120} - \frac{239}{120} = 13 + \frac{100}{120} - 1\frac{119}{120}$$
$$= 12 + \frac{100}{120} - \frac{119}{120} = 11 + 1\frac{100}{120} - \frac{119}{120}$$
$$= 11\ \frac{220 - 119}{120} = \mathbf{11\tfrac{1}{120}}.$$

This, of course, comes to the same thing as the above.

Exercise 18

Subtract—

(1) $\frac{3}{8}$ from $\frac{5}{8}$. (2) $\frac{7}{15}$ from $\frac{11}{15}$. (3) $\frac{1}{5}$ from $\frac{1}{2}$. (4) $\frac{3}{20}$ from $\frac{1}{4}$.

Simplify—

(5) $\frac{7}{8} - \frac{2}{5}$. (6) $\frac{19}{20} - \frac{3}{5}$. (7) $5\frac{3}{8} - 4\frac{1}{2}$. (8) $19\frac{5}{27} - 11\frac{11}{12}$. (9) $10\frac{4}{5} - 9\frac{14}{15}$. (10) $1\frac{6}{49} - \frac{23}{42}$.

Find the difference between—

(11) $4\frac{3}{4}$ and $2\frac{1}{8}$. (12) $10\frac{7}{16}$ and $8\frac{13}{16}$. (13) $\frac{1}{4}$ and $\frac{1}{20}$. (14) $\frac{1}{2}$ and $\frac{27}{52}$. (15) $2\frac{1}{15}$ and $3\frac{1}{5}$. (16) $100\frac{1}{15}$ and $24\frac{1}{2}$.

Simplify—

(17) $4\frac{3}{8} + 7\frac{5}{8} - \frac{1}{4} - 6\frac{1}{8}$. (18) $\frac{1}{2\frac{1}{2}} - 3\frac{7}{8} + 5\frac{1}{6}$.

(19) $6\frac{7}{27} - 2\frac{7}{12} + 5\frac{1}{18} - 3\frac{7}{24}$. (20) $30\frac{1}{30} - 22\frac{7}{25} + \frac{1}{2} - 3\frac{5}{6}$.

63. Multiplication by a Fraction.—When dealing with multiplication we said that it is really an addition of numbers.

To multiply 3 by 4 is to find the sum of 3 added to itself 4 times, i.e. $3 \times 4 = 3 + 3 + 3 + 3 = 12$.

We have added 3 to itself as many times as there are units in 4.

Now $4 = 1 + 1 + 1 + 1$, and $3 \times 4 = 3 + 3 + 3 + 3$; ∴ we may restate our definition of multiplication thus:

To multiply one number by a second is to do to the first what you did to unity to obtain the second.

Consider $\frac{3}{8} \times \frac{5}{11}$.

We must do to $\frac{3}{8}$ what we did to unity to obtain $\frac{5}{11}$.

But we obtain $\frac{5}{11}$ from unity by dividing unity into 11 equal parts and taking 5 of them.

∴ we must divide $\frac{3}{8}$ into 11 equal parts and take 5 of them. Each of the eleven equal parts will $= \frac{3}{8 \times 11}$ (§ 54), and if we take five of these equal parts we get $\frac{3 \times 5}{8 \times 11}$ (§ 53).

Hence, the product of two fractions is a fraction whose numerator is the product of the two numerators and whose denominator is the product of the two denominators.

By a continued application of the above rule we find that the product of any number of fractions is a fraction whose numerator is the continued product of all the numerators, and whose denominator is the continued product of all the denominators.

Thus, $\frac{3}{8} \times \frac{5}{11} \times \frac{13}{17} = \mathbf{\frac{3 \times 5 \times 13}{8 \times 11 \times 17}}$.

Examples:

(1) Multiply $\frac{2}{9}$ by $\frac{3}{11}$.

$\frac{2}{\cancel{9}_3} \times \frac{\cancel{3}^1}{11} = \frac{2}{33}$ (dividing numerator and denominator by the common factor 3).

(2) Multiply $1\frac{7}{13}$ by $5\frac{1}{5}$.

First convert the mixed numbers into improper fractions.

$$1\tfrac{7}{15} \times 5\tfrac{1}{5} = \frac{\overset{4}{\cancel{20}}}{\underset{1}{\cancel{15}}} \times \frac{\overset{2}{\cancel{10}}}{\underset{1}{\cancel{5}}} = 4 \times 2 = \mathbf{8}.$$

(3) Simplify $\frac{12}{13} \times 3\frac{3}{4} \times 1\frac{1}{35} \times \frac{39}{51} \times \frac{3}{8}$.

$$\frac{\overset{1}{\cancel{12}}}{\underset{1}{\cancel{13}}} \times \frac{\overset{3}{\cancel{15}}}{\underset{1}{\cancel{4}}} \times \frac{\overset{18}{\cancel{36}}}{35} \times \frac{\overset{1}{\cancel{39}}}{\underset{17}{\cancel{51}}} \times \frac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{8}}} = \mathbf{\frac{594}{595}}.$$

64. A fraction of a fraction is called a **compound fraction.**

Thus, $\frac{2}{7}$ of $\frac{8}{9}$ is a compound fraction.

To find the value of $\frac{2}{7}$ of $\frac{8}{9}$ we must divide $\frac{8}{9}$ into 7 equal parts and then take 2 of them. Hence we see that $\frac{2}{7}$ of $\frac{8}{9}$ is the same as $\frac{2}{7} \times \frac{8}{9}$.

i.e. $\frac{2}{7}$ of $\frac{8}{9} = \mathbf{\frac{16}{63}}$.

Examples:

(1) $\frac{5}{9}$ of $\frac{8}{15}$ of $2\frac{5}{11}$ of $1\frac{5}{16}$

$$= \frac{\overset{1}{\cancel{5}}}{\underset{1}{\cancel{9}}} \times \frac{\overset{1}{\cancel{8}}}{\underset{1}{\cancel{15}}} \times \frac{\overset{1}{\cancel{27}}}{11} \times \frac{21}{\underset{2}{\cancel{16}}} = \mathbf{\frac{21}{22}}.$$

(2) $\frac{2}{3}$ of $\frac{5}{9} \times \frac{9}{25}$ of $2\frac{1}{4} = \frac{\overset{1}{\cancel{2}}}{\underset{1}{\cancel{3}}} \times \frac{\overset{1}{\cancel{5}}}{\underset{1}{\cancel{9}}} \times \frac{\overset{1}{\cancel{9}}}{\underset{5}{\cancel{25}}} \times \frac{\overset{3}{\cancel{9}}}{\underset{2}{\cancel{4}}} = \mathbf{\frac{3}{10}}$

Exercise 19

Simplify—

(1) $\frac{4}{5} \times 1\frac{5}{11}$. (2) $1\frac{7}{8} \times \frac{1}{20}$. (3) $\frac{2}{3} \times \frac{7}{10}$. (4) $1\frac{5}{8} \times \frac{20}{35}$. (5) $\frac{7}{55} \times 5\frac{1}{5} \times \frac{31}{42} \times \frac{15}{62} \times 3\frac{1}{3}$. (6) $2\frac{1}{4} \times 3\frac{1}{3} \times 4\frac{1}{2} \times 5\frac{1}{6} \times 6\frac{2}{3}$. (7) $1\frac{7}{17} \times 6\frac{1}{2} \times \frac{1}{25} \times 3\frac{1}{3} \times \frac{261}{270} \times 1\frac{19}{26}$. (8) $\frac{2}{3}$ of $\frac{5}{7}$. (9) $\frac{3}{5}$ of $\frac{20}{21}$. (10) $\frac{7}{8}$ of $\frac{12}{35}$. (11) $\frac{6}{7}$ of $\frac{15}{36}$. (12) $\frac{3}{4}$ of $4\frac{1}{4} \times \frac{1}{3}$ of $\frac{42}{85} \times 10$. (13) $\frac{39}{44}$ of $1\frac{2}{5} \times 5\frac{7}{8} \times 2\frac{13}{21}$. (14) $\frac{95}{114}$ of $\frac{17}{21} \times \frac{87}{116}$ of $\frac{126}{145} \times \frac{4}{7}$ of $1\frac{2}{3}$.

(15) Find the continued product of $\frac{147}{160}$, $\frac{355}{826}$, $\frac{1728}{3627}$, and $2\frac{43}{44}$.

Key to Exercise 8

(1) 268632. (2) £25. (3) 220 men. (4) 640 men. (5) £420, £60. (6) 9 yds. (7) 4 hours.

Key to Exercise 9

(1) 8. (2) 5. (3) 12. (4) 4. (5) 39. (6) 5. (7) 504. (8) 2345. (9) 112. (10) 7853. (11) 2. (12) 91. (13) 271. (14) 368.

Key to Exercise 10

(1) 18. (2) 42. (3) 100. (4) 105. (5) 180. (6) 441. (7) 3360. (8) 702. (9) 450. (10) 14014. (11) 8211. (12) 9128592. (13) 275847. (14) 344250.

Key to Exercise 11

(1) 103519. (2) 1405. (3) 769. (4) 162 times. (5) 9976 and 10148. (6) 4978. (7) 9 groups of blue and 11 groups of red. (8) 187. (9) 6 minutes. (10) 60 miles.

Key to Exercise 12

(1) 120. (2) 190. (3) 2002. (4) 0. (5) 91. (6) 1606.

Key to Exercise 13

(1) $\frac{2}{3}$, $\frac{1}{5}$, $\frac{6}{43}$, $\frac{27}{100}$, $\frac{433}{1004}$, $\frac{647}{21}$.

(2) Two fifths, four nineteenths, twenty-two thirty-sevenths, one hundred and forty-one three hundred and seventy twoths, three hundred and ninety-seven four hundred and oneths, one thousand and eight three hundred and ninety twoths, four hundred and fifty-one ten thousand and oneths.

(3) (*a*) 12 shillings; (*b*) 9d.; (*c*) 3d.; (*d*) 1 foot (or 12 inches); (*e*) 9 hours; (*f*) £4; (*g*) £2 8s. 0d.; (*h*) 63 inches; (*k*) 16 minutes; (*l*) 4s.; (*m*) 21 seconds; (*n*) 4d.

Key to Exercise 14

(1) $\frac{90}{11}$. (2) $\frac{329}{13}$. (3) $\frac{186}{5}$. (4) $\frac{1709}{100}$. (5) $\frac{3643}{51}$. (6) $\frac{2999}{1000}$. (7) $1\frac{98553}{4750}$. (8) $\frac{2606}{25}$. (9) $2\frac{3}{8}$. (10) $1\frac{1}{10}$. (11) $4\frac{5}{8}$. (12) $25\frac{21}{48}$. (13) 7. (14) $19\frac{83}{101}$. (15) $6\frac{443}{500}$. (16) $2\frac{2475}{8005}$. (17) $99\frac{902}{1001}$. (18) 125. (19) $2\frac{4}{8}$, $4\frac{0}{8}$, $\frac{56}{8}$, $\frac{72}{8}$. (20) $\frac{30}{15}$, $\frac{60}{15}$, $\frac{90}{15}$, $\frac{120}{15}$.

M. A. L.

ALGEBRA.—VI

46. The following equations should be carefully noted and proved:

$$\frac{a^2 + 2ab + b^2}{a + b} = \frac{(a + b)^2}{a + b} = a + b \quad . \quad . \quad \text{(i)}$$

$$\frac{a^2 - 2ab + b^2}{a - b} = \frac{(a - b)^2}{a - b} = a - b \quad . \quad . \quad \text{(ii)}$$

$$\frac{a^2 - b^2}{a + b} = a - b \qquad \frac{a^2 - b^2}{a - b} = a + b.$$

These two results may be combined thus:

$$\frac{a^2 - b^2}{a \pm b} = a \mp b \quad . \quad . \quad . \quad . \quad . \quad \text{(iii)}$$

$$\frac{a^3 \mp b^3}{a \mp b} = a^2 \pm ab + b^2 \quad . \quad . \quad . \quad . \quad \text{(iv)}$$

$$\frac{a^4 - b^4}{a \mp b} = a^3 \pm a^2b + ab^2 \pm b^3 \quad . \quad . \quad . \quad \text{(v)}$$

$$\frac{a^4 + a^2b^2 + b^4}{a^2 \mp ab + b^2} = a^2 \pm ab + b^2 \quad . \quad . \quad \text{(vi)}$$

$$\frac{a^3 + b^3 + c^3 - 3abc}{a + b + c} = a^2 + b^2 + c^2 - ab - bc - ca \quad \text{(vii)}$$

In general we may state that—

(i) $a^n - b^n$ is divisible by $(a - b)$ where n is any integer.

(ii) $a^n - b^n$ is divisible by $(a + b)$ where n is any **even** integer.

(iii) $a^n + b^n$ is divisible by $(a + b)$ where n is any **odd** integer.

(iv) $a^n + b^n$ is never divisible by $(a + b)$ or $(a - b)$ where n is any **even** integer.

47. Factors.

An algebraic expression is said to be integral when no letter occurs in the denominator of any term. Thus $2x - 3y$ and $\frac{1}{2}a^2 + \frac{1}{4}ab$ are integral expressions.

An expression is said to be integral with respect to a certain letter or certain letters when the letter or letters do not occur in

the denominator of any term. Thus $\frac{x^2}{a}+\frac{ax}{b}$ is integral with respect to x, and $\frac{x}{a^2}+\frac{xy}{ab}+\frac{y^2}{b^2}$ is integral with respect to x and y.

An expression is rational when it contains no surds.

We shall now deal with the **factors** of certain simple, integral, rational expressions.

By a factor of such an expression we mean an algebraic expression which is rational and integral with respect to a certain letter or certain letters, and which exactly divides the first expression.

48. Monomial factors.—When some letter or letters are common to every term of an algebraic expression, then the whole expression is divisible by the letter or letters.

Thus $2x + bx + cx = x(2a + b + c)$
$3x^2 + xy + x = x(3x + y + 1)$
$3a^2b^2x + 2a^2b^2y = a^2b^2(3x + 2y)$.

Such factors can be seen by inspection.

49. A relation of equality which is true for all values of the letters concerned is called an identity.

We may often find the factors of an expression by comparison with known identities.

Thus, knowing that $a^2 - b^2 = (a + b)(a - b)$ we can find the factors $4a^2 - 9b^4$
$4a^2 - 9b^4 = (2a)^2 - (3b^2)^2 = (2a + 3b^2)(2a - 3b^2)$.
Again, $x^2 - 2 = (x^2) - (\sqrt{2})^2 = (x + \sqrt{2})(x - \sqrt{2})$.
And $a^3xy - ab^2xy = axy(a^2 - b^2) = axy(a + b)(a - b)$.
Similarly from the identity $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$ we have
$8x^3y^3 + 27z^3 = (2xy)^3 + (3z)^3 = (2xy + 3z)(4x^2y^2 - 6xyz + 9z^2)$ and $x^9 + y^9 = (x^3)^3 + (y^3)^3 = (x^3 + y^3)(x^6 - x^3y^3 + y^6) = (x + y)(x^2 - xy + y^2)(x^6 - x^3y^3 + y^6)$.
And from the identity $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$ we have

$$\begin{aligned}(x + y)^3 - y^3 &= (x + y - y)\{(x + y)^2 + y(x + y) + y^2\}\\ &= x\{x^2 + 2xy + y^2 + xy + y^2 + y^2\}\\ &= x(x^2 + 3xy + 3y^2).\end{aligned}$$

We give below a few more examples of solution into factors.

(1) $(a - b)^2 - (c - d)^2 = (a - b + c - d)(a - b - c + d)$.

(2) $(a^2 + b^2 - c^2)^2 - 4a^2b^2 = \{a^2 + b^2 - c^2 + 2ab\}\{a^2 + b^2 - c^2 - 2ab\}$
$= \{(a^2 + 2ab + b^2) - c^2\}\{(a^2 - 2ab + b^2) - c^2\}$
$= \{(a + b)^2 - c^2\}\{(a - b)^2 - c^2\}$
$= (a + b + c)(a + b - c)(a - b + c)(a - b - c)$.

50. We know that $(x + a)(x + b) = x^2 + (a + b)x + ab$. Now we can often find by inspection the factors of an expression of the form $x^2 + px + q$ by means of the above identity. For if we can find two quantities a and b such that $a + b = p$ and $ab = q$, it follows that the expressions $x^2 + px + q$ and $x^2 + (a + b)x + ab$ will be identical, and since $(x + a)(x + b)$ are the factors of the latter, they must also be factors of the former.

Consider $x^2 + 6x + 8$. The factors are $(x + a)(x + b)$ where $a + b = 6$ and $ab = 8$. We therefore want two numbers whose sum is 6 and whose product is 8. Now the pairs of numbers whose product is 8 are 1 and 8, and 2 and 4. And the sum of 2 and 4 is 6. Hence 2 and 4 are the numbers we require.

Thus $x^2 + 6x + 8 = (x + 2)(x + 4)$.

Again, to find the factors of $x^2 - 9x + 20$. We must find two numbers whose product is $+20$ and whose sum is -9. Now as their product is positive, the numbers must be either both positive or both negative; and since their sum is negative, they must both be negative. Now the negative numbers whose product is 20 are -1 and -20, -2 and -10, -4 and -5. The sum of the last two is -9. Hence -4 and -5 are the numbers required. Thus $x^2 - 9x + 20 = (x - 4)(x - 5)$.

Again, find the factors of $x^2 + 3x - 28$. We want two numbers whose sum is $+3$ and whose product is -28. Since their product is negative, one number must be positive and one must be negative. Since their sum is positive, the greater number must be positive. The pairs of numbers whose product is -28 are -1 and 28, -2 and 14, -4 and 7. The sum of the last pair is $+3$, hence the numbers are -4 and $+7$; hence $x^2 + 3x - 28 = (x - 4)(x + 7)$.

Lastly, find the factors of $x^2 - 2x - 15$. The sum of the numbers must be -2 and their product -15. Hence as before one number must be positive and one negative (since their product is negative), and as their sum is negative, the greater number must be negative. The pairs of numbers whose product is -15 are 1 and -15, 3 and -5. The sum of the latter is -2, hence $x^2 - 2x - 15 = (x - 5)(x + 3)$.

If the factors of $x^2 + px + q = (x + a)(x + b)$, then it follows that the factors of $x^2 + pxy + qy^2$ are $(x + ay)(x + by)$ and the factors of $(x + y)^2 + p(x + y)z + qz^2 = (x + y + az)(x + y + bz)$. Thus the factors of $x^2 + 6xy + 8y^2$ are $(x + 2y)(x + 4y)$, and the factors of $(x + y)^2 - 9(x + y)z + 20z^2$ are $(x + y - 4z)(x + y - 5z)$.

Exercise 7

Divide—

(1) $x^2 + 3x + 2$ by $x + 1$.
(2) $5x^2 + 16x + 3$ by $x + 3$.
(3) $15 + 3a - 7a^2 - 4a^3$ by $5 - 4a$.
(4) $a^2 - 9b^2$ by $a - 3b$.
(5) $27x^3 + 8y^3$ by $3x + 2y$.
(6) $1 - 6x^5 + 5x^6$ by $1 - 2x + x^2$.
(7) $a^3 - 3a^2b + 3ab^2 - b^3 - c^3$ by $a - b - c$.
(8) $acx^3 + (ad - bc)x^2 - (ac + bd)x + bc$ by $ax - b$.
(9) Divide $(a^3 + b^3)$ by $a + b$, and hence write down the result of $\{(a + b)^3 + c^3\} \div (a + b + c)$.
(10) Divide $x^3 - y^3$ by $x - y$, and hence write down the result of
(1) $(x^3 - 3x^2y + 3xy^2 - y^3 - z^3) \div (x - y - z)$
(2) $\{(x + y)^3 - 27z^3\} \div (x + y - 3z)$.

Exercise 8

Find the factors of—

(1) $9 - a^2$. (2) $36x^2 - 25b^2$. (3) $a^2b^4c^6 - x^{16}$. (4) $x^2 - (2b - 3c)^2$. (5) $(x - 7y + z)^2 - (7y - z)^2$. (6) $a^3 + 27b^3$. (7) $(x^2 - 2yz)^3 - 8y^3z^3$. (8) $(4x^2 - 3x - 2)^2 - (4x^2 + 3x - 2)^2$. (9) $a^2b - 4a^2b^2 + 3ab^3$.

(10) $(a+b)^2-7(a+b)c+10c^2$. (11) $y^2+y-110$.
(12) $x^2-9x-90$. (13) $16a^4-81b^4$. (14) x^6-y^6.
(15) $4(xy-ab)^2-(x^2+y^2-a^2-b^2)^2$.

51. To find the factors of an expression of the second degree in any particular letter.

The most general quadratic expression in x is of the form ax^2+bx+c where a, b, c do not contain x.

To find these factors we must change the form of the expression so that **it assumes the form of the difference of two squares.**

Now $x^2+2mx+m^2$ is a perfect square, hence if we have an expression of the form x^2+2mx we must add m^2 to it in order to complete the square, i.e. we must **add the square of half the coefficient of x.**

Thus to make x^2+6x a perfect square we must add $\left(\frac{6}{2}\right)^2=3^2=9$. To make x^2-5x a perfect square we must add $\left(\frac{5}{2}\right)^2=\frac{25}{4}$, and to make x^2+px a perfect square we must add $\left(\frac{p}{2}\right)^2=\frac{p^2}{4}$.

52. *To find the factors of* ax^2+bx+c.

$$ax^2+bx+c=a\left\{x^2+\frac{b}{a}x+\frac{c}{a}\right\}$$

Now to make $x^2+\frac{b}{a}x$ a perfect square we must add $\left(\frac{b}{2a}\right)^2=\frac{b^2}{4a^2}$, it then becomes $\left(x+\frac{b}{2a}\right)^2$. Clearly if we first add and then subtract $\left(\frac{b}{2a}\right)^2$ to the expression in the brackets we shall not alter the value of the expression, and we have

$$a\left\{x^2+\frac{b}{a}x+\frac{b^2}{4a^2}-\frac{b^2}{4a^2}+\frac{c}{a}\right\}$$
$$=a\left\{\left(x+\frac{b}{2a}\right)^2-\left(\frac{b^2}{4a^2}-\frac{c}{a}\right)\right\}$$
$$=a\left\{\left(x+\frac{b}{2a}\right)^2-\left(\frac{b^2}{4a^2}-\frac{4ac}{4a^2}\right)\right\}$$
$$=a\left\{\left(x+\frac{b}{2a}\right)^2-\frac{b^2-4ac}{4a^2}\right\}$$
$$=a\left\{\left(x+\frac{b}{2a}\right)^2-\left(\sqrt{\frac{b^2-4ac}{4a^2}}\right)^2\right\}$$

Now this is in the form of the difference of two squares $\therefore ax^2+bx+c$

$$=a\left\{x+\frac{b}{2a}+\sqrt{\frac{b^2-4ac}{4a^2}}\right\}\left\{x+\frac{b}{2a}-\sqrt{\frac{b^2-4ac}{4a^2}}\right\}$$

and the required factors have been found. Notice that though these factors contain a square root, they are **rational and integral with respect to** x.

Examples:

(1) To find the factors of $x^2+8x+12$.

$$x^2+8x+12=x^2+8x+(4)^2-4^2+12$$
$$=x^2+8x+16-16+12$$
$$=(x+4)^2-4=(x+4)^2-2^2$$
$$=(x+4+2)(x+4-2)=(x+6)(x+2).$$

(2) To find the factors of x^2-7x+5.

$$x^2-7x+5=x^2-7x+\left(\frac{7}{2}\right)^2-\left(\frac{7}{2}\right)^2+5$$
$$=\left(x-\frac{7}{2}\right)^2-\left(\frac{49}{4}-5\right)$$
$$=\left(x-\frac{7}{2}\right)^2-\frac{29}{4}=\left(x-\frac{7}{2}\right)^2-\left(\sqrt{\frac{29}{4}}\right)^2$$
$$=\left(x-\frac{7}{2}+\sqrt{\frac{29}{4}}\right)\left(x-\frac{7}{2}-\sqrt{\frac{29}{4}}\right).$$

(3) To find the factors of $5x^2-8x+3$.

$$5x^2-8x+3=5\left(x^2-\frac{8}{5}x+\frac{3}{5}\right)=5\left\{x^2-\frac{8}{5}x+\left(\frac{4}{5}\right)^2-\left(\frac{4}{5}\right)^2+\frac{3}{5}\right\}$$
$$=5\left\{\left(x-\frac{4}{5}\right)^2-\frac{16-15}{25}\right\}=5\left\{\left(x-\frac{4}{5}\right)^2-\frac{1}{25}\right\}=5\left\{\left(x-\frac{4}{5}\right)^2-\left(\sqrt{\frac{1}{25}}\right)^2\right\}$$
$$=5\left\{\left(x-\frac{4}{5}\right)^2-\left(\frac{1}{5}\right)^2\right\}=5\left(x-\frac{4}{5}+\frac{1}{5}\right)\left(x-\frac{4}{5}+\frac{1}{5}\right)$$
$$=5\left(x-\frac{3}{5}\right)\left(x-1\right)=\left(5x-3\right)\left(x-1\right).$$

(4) To find the factors of $x^2+2axy-(b^2+2ab)y^2$.

$$x^2+2axy-(b^2+2ab)y^2=x^2+2axy+(ay)^2-(ay)^2-(b^2+2ab)y^2$$
$$=(x+ay)^2-(a^2+2ab+b^2)y^2=(x+ay)^2-(a+b)^2y^2$$
$$=\{x+ay-(a+b)y\}\{x+ay+(a+b)y\}$$
$$=(x-by)\{x+(2a+b)y\}.$$

When the student has thoroughly grasped the principle of the above method, he can save time by using the formula $a+bx+c=a\left\{x+\frac{b}{2a}+\sqrt{\frac{b^2-4ac}{4a^2}}\right\}\left\{x+\frac{b}{2a}-\sqrt{\frac{b^2-4ac}{4a^2}}\right\}$ and substitute in this the special values of a, b and c.

Thus $2x^2+5x-12=2\left\{x+\frac{5}{2\times2}+\sqrt{\frac{25-4\times2\times-(12)}{4+4}}\right\}\left\{x+\frac{5}{2\times2}-\sqrt{\frac{25-4\times2\times(-12)}{4\times4}}\right\}$

$$=2\left\{x+\frac{5}{4}+\sqrt{\frac{25+96}{16}}\right\}\left\{x+\frac{5}{4}-\sqrt{\frac{25+96}{16}}\right\}$$
$$=2\left(x+\frac{5}{4}+\frac{11}{4}\right)\left(x+\frac{5}{4}-\frac{11}{4}\right)$$
$$=2(x+4)\left(x-\frac{3}{2}\right)=(x+4)(2x-3).$$

He is, however, advised to work examples out from first principles, until he is thoroughly familiar with the work.

53. We will now further examine the formula

$$ax^2 + bx + c = a\left\{x + \frac{b}{2a} + \sqrt{\frac{b^2 - 4ac}{4a^2}}\right\}$$
$$\left\{x + \frac{b}{2a} - \sqrt{\frac{b^2 - 4ac}{4a^2}}\right\}$$

For particular values of a, b and c, $\frac{b^2 - 4ac}{4a^2}$ may be (1) positive, (2) zero, (3) negative.

(1) If $\frac{b^2 - 4ac}{4a^2}$ is positive, then the two factors will be rational or irrational according as $b^2 - 4ac$ is or is not a perfect square. ($4a^2$ is obviously a perfect square.)

(2) If $\frac{b^2 - 4ac}{4a^2}$ be zero, the factors become

$$a\left(x + \frac{b}{2a}\right)\left(x + \frac{b}{2a}\right)$$

i.e. $ax^2 + bx + c$ is a perfect square. This is the case if $b^2 - 4ac = 0$.

(3) If $\frac{b^2 - 4ac}{4a^2}$ is negative, then we can find no positive or negative quantity whose square equals $\frac{b^2 - 4ac}{4a^2}$, since all squares are positive.

Now expressions of the form $\sqrt{-p}$ where p is positive are called **imaginary** quantities, as opposed to **real** quantities. Hence in case (3) we can find no **real** factors of $ax^2 + bx + c$.

Key to Exercise 3

(1) 4. (2) $24a^2$. (3) $-3a$. (4) $-17a$. (5) $-8\,a^9\,b^9\,c^9$. (6) $-4a^4b^2cd^2$. (7) $\frac{7x}{yz}$. (8) $-2x^4y^6$. (9) $\frac{byz}{3x^4}$. (10) $\frac{a^{16}}{b^{12}}$ (11) a^{90}. (12) $x^{1\cdot2\cdot3\cdot4\cdot5\cdot\cdots(m-2)(m-1)m}$.

Key to Exercise 4

(1) $5a + 5b$. (2) $4x - 6y + 5z$. (3) $\frac{1}{4}a + \frac{3}{8}b - \frac{2}{8}c$. (4) $2x^4$. (5) $3x^2 + y^2$. (6) $4x + 9y$. (7) $m^2 + n^2$. (8) $-y$. (9) $2z - y$. (10) $7a - 2c - 4d$.

Key to Exercise 5

(1) $12x^2 - 7x - 10$. (2) $-15\,a^2 + 22\,ab - 8b^2$. (3) $a^3 - 1$. (4) $a^3 - b^3$. (5) $8 - 8x + 4x^2 - x^3$. (6) $1 - a^2b^2 + 2a^3b^3 - a^4b^4$. (7) $10x^4 - 7x^3y - 38x^2y^2 - 7xy^3 + 12y^4$. (8) $3a^4 - 17a^3b + 26a^2b^2 - 2ab^3 - 12b^4$. (9) $2a^6x^6 - 4a^5x^5y^2 + a^4x^4y^4 + 8a^2x^2y^8 + 3axy^{11} - 12y^{12}$. (10) $x^3 + y^3 + z^3 - 3xyz$. (11) $8ac$. (12) $a^3 + b^3$. (13) $1 - a^2$.

Key to Exercise 6

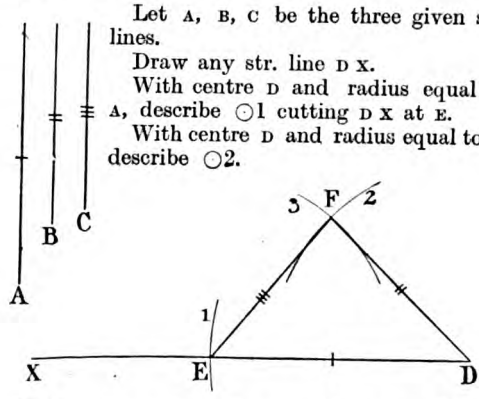
(1) $x^{12} - 1$. (2) $(a^4 - b^4)^3$. (3) $a^8 + 2a^5 - 3a^4 - 2a^3 + 4a^2 + 2a - 3$. (4) $x^3 - 2x^2y - 2y - 8y^2 - 8y^3 - 16y^4 - 1$. (5) $a^8 + 16a^4b^4 + 256b^4$. (6) $x^2 + y^2 + z^2 - 2xy - 2xz + 2yz$, $a^2 + 4b^2 + 9c^2 + 4ab - 6ac - 12bc$, $4a^2 + 9b^2 + 16c^2 - 12ab + 16ac - 24bc$, $a^6 + 2a^5 - a^4 - 4a^3 - a^2 + 2a + 1$, $x^6 + 2x^5 + 3x^4 - x^2 - 2x + 1$. (7) $8a^3 + 36a^2b + 54ab^2 + 27b^3$, $64a^3 - 240a^2b + 300ab^2 - 125b^3$, $a^3 + 6a^2b - 9a^2c + 12ab^2 - 27ac^2 - 36abc + 8b^3 - 36b^2c + 54bc^2 - 27c^3$, $8a^3 - 27b^3 + 64c^3 - 36a^2b + 48a^2c + 54ab^2 + 96ac^2 + 108b^2c - 144bc^2 - 144abc$, $1 - 3a + 5a^3 - 3a^5 - a^6$.

M. A. L.

GEOMETRY.—V

Proposition 17.—Problem

To construct a triangle with its sides equal to three given straight lines, any two of which are greater than the third.



Let A, B, C be the three given str. lines.

Draw any str. line D X.

With centre D and radius equal to A, describe ⊙1 cutting D X at E.

With centre D and radius equal to B, describe ⊙2.

With centre E and radius equal to C, describe ⊙3 cutting ⊙2 at F.

Join E F, D F.

D E F is the △ required.

Proof.—D E is a radius of ⊙1 = A (all the radii of a ⊙ are equal by definition)

D F is a radius of ⊙2 = B

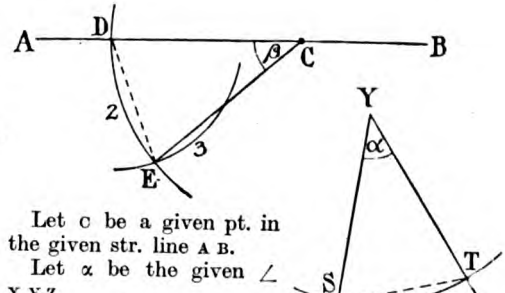
E F is a radius of ⊙3 = C

i.e. △ D E F has its sides = the given str. lines A, B, C.

Note.—The ⊙s 2 and 3 will meet at a second point below D E, hence this construction will give two triangles satisfying the given conditions.

Proposition 18.—Problem

At a given point in a given straight line, to draw a line making with the given straight line an angle equal to a given angle.



Let C be a given pt. in the given str. line A B.

Let α be the given ∠ X Y Z.

With centre X and any radius describe ⊙1 cutting Y X and Y Z at S and T.

With centre C and the same radius describe ⊙2 cutting A B at D.

Join S T.

With centre D and radius = S T, describe ⊙3 cutting ⊙2 at E.

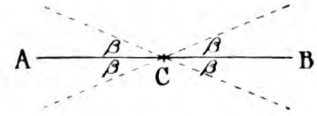
Join E C.

Then E C is the required straight line making with A C an $\angle$ β which is equal to α.

Proof.—Join D E.

In $\triangle$s C E D, Y T S,
C D = Y S (radii of equal $\bigcirc$s)
C E = Y T (radii of equal $\bigcirc$s)
D E = S T (D E = radius of $\bigcirc$3 = S T)
$\therefore$ $\triangle$ C E D $\equiv$ $\triangle$ Y T S
i.e. $\beta = \alpha$
i.e. E C makes with A C an $\angle = \alpha$.

Note that this construction will give another $\angle = \alpha$ on the other side of A B, and that by producing the lines we can get two more vertically opposite and $\therefore$ equal $\angle$s.

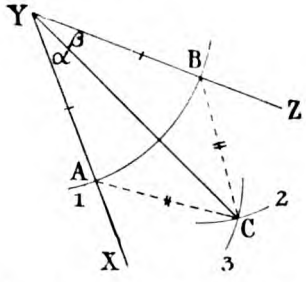


Proposition 19.—Problem

To bisect a given angle.

Let X Y Z be the given $\angle$.

With centre Y and any radius describe the $\bigcirc$1 cutting Y X and Y Z at A and B.



With centre A and radius = A B describe $\bigcirc$2 and with centre B and the same radius describe $\bigcirc$3 cutting $\bigcirc$2 at C.

Join Y C. Then Y C bisects $\angle$ X Y Z.

Proof.—Join A C, B C.

In $\triangle$s A Y C, B Y C
A Y = B Y (radii of the same $\bigcirc$)
A C = B C (radii of equal $\bigcirc$s)
Y C is common to both $\triangle$s
$\therefore$ $\triangle$ A Y C $\equiv$ $\triangle$ B Y C (Prop. 8)
i.e. $\alpha = \beta$
i.e. $\angle$ X Y Z is bisected by Y C.

Proposition 20.—Problem

To bisect a given straight line.

Let A B be the given str. line.

With centre A and any convenient radius describe $\bigcirc$1.

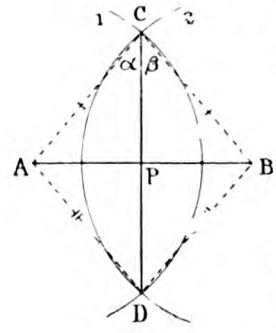
With centre B and the same radius describe $\bigcirc$2 cutting $\bigcirc$1 at C and D.

Join C D cutting A B at P.

Then A B is bisected at P.

Proof.—Join A C, B C, A D, B D.

In $\triangle$s A C D, B C D
A C = B C (radii of equal $\bigcirc$s)
A D = B D (radii of equal $\bigcirc$s)
C D is common to both $\triangle$s



$\therefore$ $\triangle$ A C D $\equiv$ $\triangle$ B C D (Prop. 8)
$\therefore$ $\alpha = \beta$.
In $\triangle$s A C P, B C P
A C = B C (radii of equal $\bigcirc$s)
C P is common to both $\triangle$s
included $\angle$ α = included $\angle$ β
$\therefore$ $\triangle$ A C P $\equiv$ $\triangle$ B C P (Prop. 5)
$\therefore$ A P = B P
i.e. A B is bisected at P

Proposition 21.—Problem

From a given point in a given straight line to draw a straight line at right angles to the given straight line.

Let X Y be the given str. line and let A be the given point in it.

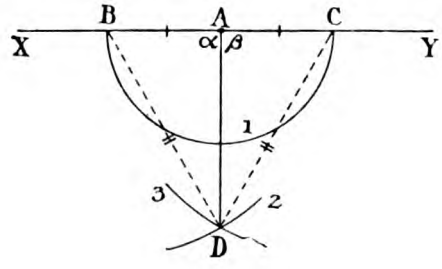
With centre A and any convenient radius describe the $\bigcirc$1 cutting X Y at B and C.

With centre B and radius = B C describe $\bigcirc$2.

With centre C and the same radius describe $\bigcirc$3, cutting $\bigcirc$2 at D.

Join A D.

Then A D is at rt. $\angle$s to X Y.



Proof.—Join B D, C D.

In $\triangle$s A B D, A C D
A B = A C (radii of the same $\bigcirc$)
B D = C D (radii of equal $\bigcirc$s)
A D is common to both $\triangle$s
$\therefore$ $\triangle$ A B D $\equiv$ $\triangle$ A C D (Prop. 8)
$\therefore$ $\alpha = \beta$.
But these are adjacent $\angle$s $\therefore$ each is a rt. $\angle$
i.e. D A is at rt. $\angle$s to X Y.

Alternative Method.—To be used when A is very near one end of X Y.

Take any pt. O outside X Y fairly near the opposite end of X Y to which A is near.

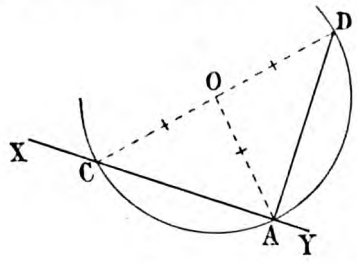
With centre O and radius O A describe a $\bigcirc$, cutting X Y at C.

Join C O and produce C O to cut the $\bigcirc$ again at D.

Join D A. Then A D is at rt. $\angle$s to X Y.

Proof.—Join O A.

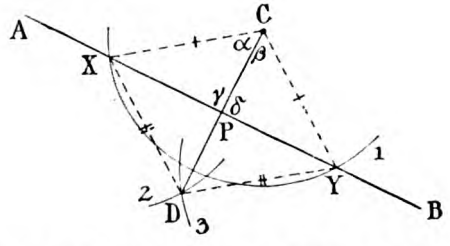
△ O A C is isos. (O C and O A are radii of same ○)
∴ ∠ O A C = ∠ O C A
similarly ∠ O A D = ∠ O D A



∴ ∠ O A C + ∠ O A D = ∠ O C A + ∠ O D A
∴ ∠ O A C + ∠ O A D = 1 rt. ∠ (∵ ∠s O C A, O A C, O D A, O A D being the ∠s of △ C A D together = 2 rt. ∠s)
i.e. ∠ C A D = 1 rt. ∠
i.e. A D is at rt. ∠s to X Y.

Proposition 22.—Problem

To draw a straight line perpendicular to a given straight line of unlimited length, from a given point not on the line.



Let A B be the given str. line and C the given pt. outside it.

With centre C and any convenient radius describe ○1 cutting A B at X and Y.

With centre X and the same radius describe ○2.

With centre Y and the same radius describe ○3, cutting ○2 at D.

Join C D, cutting A B at P.

Then C P is ⊥ʳ to A B.

Proof.—In △s C X D, C Y D

C X = C Y (radii of the same ○)
X D = Y D (radii of equal ○s)
C D is common to both.
∴ △ C X D ≡ △ C Y D (Prop. 8)
∴ α = β.

In △s C X P, C Y P

C X = C Y (radii of the same ○)
C P is common
included ∠ α = included ∠ β
∴ △ C X P ≡ △ C Y P (Prop. 5)
∴ γ = δ

But these are adjacent ∠s ∴ each is a rt. ∠.

Exercise 7

(The following exercises are problems, and the student is warned that it is not sufficient merely to do the problem, he must prove that his construction is correct.)

Construct △s with the following dimensions :—

(1) A B = 2 in, B C = 3 in, C A = 4½ in.
(2) A B = 5 in., B C = 4 in., C A = 3 in.
(3) A B = 3·4 in., B C = 5·2 in., C A = 1·9 in.
(4) A B = 7 cm., B C = 3 cm., C A = 2 cm.
(5) A B = 6·5 cm., B C = 4·8 cm., C A = 2 cm.
(6) A B = 1·7 cm., B C = 2·1 cm., C A = 3·2 cm.

Notice that in one case the construction fails, and note carefully why.

(7) By means of a protractor measure carefully the angles in each of the triangles constructed in questions 1-6.

To measure an ∠ φ by means of a protractor, place the lower edge of the protractor (or the str. line parallel to the lower edge from the middle point of which the lines marking the number of degrees radiate) along a line O A so that the middle point falls on O ; then read the number of degrees marked on the upper edge of the protractor where the line O B emerges.

If the line O B is short, it may have to be produced before the number of degrees in the angle can be read.

To make an angle of a given number of degrees, say 52°.

Draw a line O A. Place the protractor as described above, with the middle pt. of the lower edge on O and the lower edge along O A. Mark the paper at the pt. B where on the upper edge of the protractor 52° is marked, and then join B O.

Construct △s with the following dimensions :—

(8) A B = 3 in., A C = 2 in., ∠ B A C = 72°.
(9) A B = 1·5 in., A C = 7 in., ∠ B A C = 150°.
(10) A C = 2·5 in., B C = 3·7 in., ∠ B A C = 45°.
(11) A B = 2·3 in., A C = 4 in., ∠ A B C = 84°.
(12) A B = 1·8 in., A C = 2·5 in., ∠ A C B = 94°.
(13) A B = 3·2 in., ∠ A B C = 58°, ∠ B A C = 43°.
(14) B C = 2 in., ∠ A B C = 68°, ∠ B A C = 55°.

In each case measure the other ∠s and sides of the △s.

In two cases two constructions fulfil the given conditions.

Note that in (13) and (14) the 3rd ∠, which is not given, can be calculated by subtracting from 180° the sum of the two given ∠s, since the sum of the ∠s in a △ = 180°.

(15) On a given finite straight line describe an equilateral triangle.

(16) On a base B C describe an isosceles triangle A B C having each of the sides A B, A C double of B C.

(17) Find a point equidistant from two given points A and B.

(18) In triangle A B C find a point in B C equidistant from A B and A C (i.e. a pt. from which the ⊥s on A B and A C are equal).

(19) Find a point P in the side B C of a △ A B C such that A P may be half the sum of A B and A C.

(20) Find a point equidistant from two given points A and B and at a distance 1 in. from a third point C. When is this problem insoluble ?

Note.—Keys to the constructions 15-20 will be given in due course. M. A. L.

Continued from page 320.

BUSINESS AND COMMERCE

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COMMERCIAL TRAINING.—VI

ONE of the operator's first considerations must be to assume the correct position when typing.

After all, the typewriter in use is not unlike a piano, and when playing the pianist arranges the music-stool in such a way that the keyboard comes on a level with his elbows as he sits in a perfectly upright attitude. The same rule should be followed with typing, the table being sufficiently low to bring the space-bar at the elbow level with the forearm extended in a horizontal position.

As for the chair, it should be one without arms, but with a strong, supporting back, for at the typewriter, one should not sit cramped over the machine.

Typing by Touch

On the type machine the notes or stops bear upon their faces the characters they represent, but with the piano the notes are plain, and all precisely the same, except for the difference between the black notes and white ones. The pianist, however, with his eyes fixed upon his music does not follow the notes by sight, but entirely with the instinct born of experience. Typists should follow precisely the same plan, learning to type by touch and not by sight.

The task of depressing the space-bar after every word should always fall to the thumbs, and it is important that the operator shall be able to use either thumb, and not fall into the habit of using only the right thumb.

This disposes both of the thumbs and the space-bar. The next thing is to apportion the keyboard to the fingers of each hand, allowing the left hand to take the following keys :

q w e r t
a s d f g
z x c v b

and the right hand these :

y u i o p
h j k l
n m , .

Thus the first finger of each hand will take the four central rows of stops, the second finger of each hand the next rows to the outside, the third finger the next rows, leaving the little finger for the outside characters of all, and also the management of the shift-keys.

Using each Finger

In the initial stages of practising it will come naturally to the beginner to manipulate the keys only with the first fingers, and to strike the space-bar probably with two or three fingers of the right hand. This inclination must be checked at the very commencement before it develops into a habit.

In the case of a typewriter carrying one separate stop for each character, that is, eighty-five keys in eleven rows, the right hand takes the five rows to the right, the left hand covering the other six rows. Here the first finger of each hand takes two rows of keys, the second and third fingers one row each on either side, the fourth fingers a row each, and the same with the little fingers. Naturally, there are no shift-keys on such machines.

For the purposes of acquiring a knowledge of the keyboard and a sense of touch for those learners who do not possess typewriters of their own, dummy keyboards may be purchased quite cheaply, and there are also sold by dealers in typewriter sundries blank celluloid caps for fitting over and masking the keys for the benefit of tyros who are memorising the position of the letters and learning to type from touch.

Just as one musician possesses a light, even, rhythmic touch at the piano and another a heavy, leaden style, so it is with the typewriter, and the beginner cannot

expend too much trouble upon acquiring the correct touch at the very commencement. The keys should be struck quickly, sharply and evenly.

The shift-key must always be depressed to its full extent and held firmly in position, or faulty alignment can only result. Typists, further, should acquire the habit of unconsciously striking the full stop and the comma much more lightly than the letters, to avoid the possibility of piercing the paper.

Neat Spacing

With every make of machine it is highly advisable to use a backing sheet; that is, behind the sheet of paper upon which typing is to be done there should be inserted a stout sheet, not only to protect the rubber cylinder, but also to bring up the impression of the actual character more clearly. From the drawer or cabinet, therefore, we take a clean sheet of paper and place behind it the backing sheet. Holding these sheets in the left hand, we insert them under the roller and between it and the feed-plate, holding them firmly in position, whilst with the right hand we turn the knob at the right-hand side of the carriage and so draw the paper into the machine.

The exact detail here now depends upon the particular make of machine; but with most typewriters there is a figured scale of metal upon the roller, and by this scale it should be ascertained that the paper is inserted perfectly straight and strictly parallel at the top to the scale. In the case of plain paper, the first line should begin about an inch from the top.

Generally speaking, with most typewritten documents the letters should begin at the figure 10 on the scale, and when a new paragraph is to commence, at the figure 15.

We will begin to type therefore, copying some paragraphs from a newspaper or magazine, and when we get to about 74 on the scale with the carriage a little warning bell will tinkle to denote that we have nearly reached the end of the line. After a time, and, with experience, quite unconsciously, we think of the next word. If it is a very short one we realise that it will go in, whilst if it is a long one it will have either to be divided with a hyphen or else written on the next line.

With most typewriters, however, there is a "Lock" key, which may be used on occasions to fit in an extra letter or two. Say that the line finishes at 80 on the scale, which is usually too near the edge of the paper for neat and workmanlike typing. At 76 the carriage will stop, and if a letter is struck no impression will follow. Press the "Lock" key, however, and you have the margin of the extra four spaces to use.

However, we have got to the end of our first line and the last letter falls at 75 on the scale, so that the line finishes quite nicely. We have now to make a new line, and to do this we move the carrier to the right and use the line-lever (which varies in position with different makes of typewriter) to move up the paper in readiness for the next line, the two operations being carried out as one.

And here it should be explained that these line-space levers on typewriters are adjusted to give three separate spacings, which are marked on the adjusting scale near the lever 1, 2, and 3 in figures. The meaning of these numerals is, that when in position they give 1-line spacing, 2-line spacing or 3-line spacing.

We proceed with our work, having ascertained that the space-line lever is set at 2, and as we near the end of the page we watch for the last of the paper to disappear as the signal that the sheet is full.

Pads and Ribbons

There are two systems of inking the characters of a typewriter: ribbons and pads, and ribbons are the more common of the two. Ribbons are purchased on spools ready inked. They may be obtained in a wide range of colours, but purple copying and black record are the varieties used in the majority of offices.

On the machine, the ribbon is wound upon two spools, one on each side, and moves automatically from spool to spool as the typewriting proceeds. When the impression becomes faint it is the signal that the ribbon must be adjusted to wind back on to the reverse spool, and this is accomplished by moving a lever on one or both of the spools, according to the make of machine, and ribbons are wound backwards and forwards innumerable times before they are worn out, whilst on some machines they may be turned the reverse way up by the simple expedient of changing over the spools so that a completely fresh surface is presented for the type to work upon.

When a ribbon is completely worn out wind it all on to one spool, then take the spool from the machine and unreel the ribbon, throwing it into the waste-paper basket, for it is of no further use. Now take the new ribbon from the tin box in which it is supplied and unroll a short length of it. Place the

spool upon which it is wound in the machine, feed the loose end through the guides and connect it with the other spool of the machine; then wind the ribbon off on to this spool until you come to the end. Now insert the spool from the machine, throw away the spool on which the ribbon was packed, and connect up.

Pads generally cost more than ribbons, but last much longer. In the case of a Yōst machine, the keys are bunched in the central well and tied with string. Then the old pad is taken out of its socket and the new one inserted, the keys being then released to fall back into their appointed places. Some makes of pads are constructed so that they may be re-inked. A. B.

CHOOSING A CAREER.—VI

Emigration—(*continued from p.* 318). HAVING made a general survey of the Commonwealth of Australia (see page 318), we will now deal with the separate States, as was done in the case of Canada. Both these continents are so vast that their States present entirely different problems of soil and of climate. These must be carefully examined by the intending emigrant, if he is at all to get a truthful estimate of the difficulties facing him.

New South Wales, which is approximately the size of Great Britain and France joined together, is the oldest of the States. It contains a good deal of high tableland and a range of mountains, the presence of which naturally causes a good deal of variation in climate. Generally speaking—particularly in the hilly parts—the climate is healthy, though down near the coast the summer heat reaches a tropical intensity. Snow is almost unknown in the State and the atmosphere usually is dry and very clear.

Sheep form the principal product, and New South Wales leads among the wool-producing States. The most numerous class of sheep-owners are those with fewer than 500 sheep, but there are flocks consisting of 50,000 animals, though a colonist with comparatively small capital could start with sheep on a small mixed farm with every hope of success. Horse-breeding and cattle rearing form extensive industries, and flocks of Angora goats can be most profitably kept for the raising of mohair. Dairy farming, poultry-keeping and pig-raising are also profitable.

Among the crops extensively grown are oats, maize, barley, potatoes, sugar and many kinds of fruit. The State is rich in timber and coal.

From March to November is the best time to arrive in the State, and in certain circumstances emigrants are assisted in the payment of their passage. Thus, residents in New South Wales may nominate for a reduced passage a resident of the United Kingdom.

In New South Wales there are agricultural schools under Government control, and at some of them there are special classes for British boys, particulars of which may be obtained from the *Agent-General for New South Wales, Cannon Street, London, E.C.*

Victoria. This State is slightly smaller than Great Britain and forms the south-eastern corner of Australia. It has a most healthy climate.

In Victoria farms with fencing and building cost from £2 10s. to £4 10s. an acre, but first-class land near large towns may cost up to £25 an acre. Sheep-farming forms an important industry, particularly in the Western districts where the rainfall is heavier, but there is not much cattle-breeding in Victoria. Fruit forms one of the most important products, and dried apricots, peaches, pears and apples prove most profitable to the growers. Vines do particularly well, and there are about 25,000 acres of vineyards and a Government college at which lads are taught and trained in viticulture.

Wheat, oats, barley and potatoes form staple crops, and the growing of sugar beet is on the increase; whilst on the irrigated lands oranges, lemons, pomegranates, figs and practically every variety of fruit is grown.

The Immigration Department for New South Wales and Victoria, Melbourne Place, Strand, London, W.C., may be consulted regarding the prevailing conditions in these States, and nominated and assisted passages are granted in certain circumstances to suitable emigrants.

South Australia possesses a climate somewhat like that of Italy, much hotter and drier than that of the United Kingdom. From December to March the heat is intense, though the dryness of the atmosphere makes it bearable. In this State the winters are wet, but there is very little cold weather.

Here, again, the demand is principally for agriculturists, and men who have had experience of country life and who are willing to learn farm work under Australian conditions may depend upon obtaining work at practically any time of year. It is certainly better for all newcomers to work

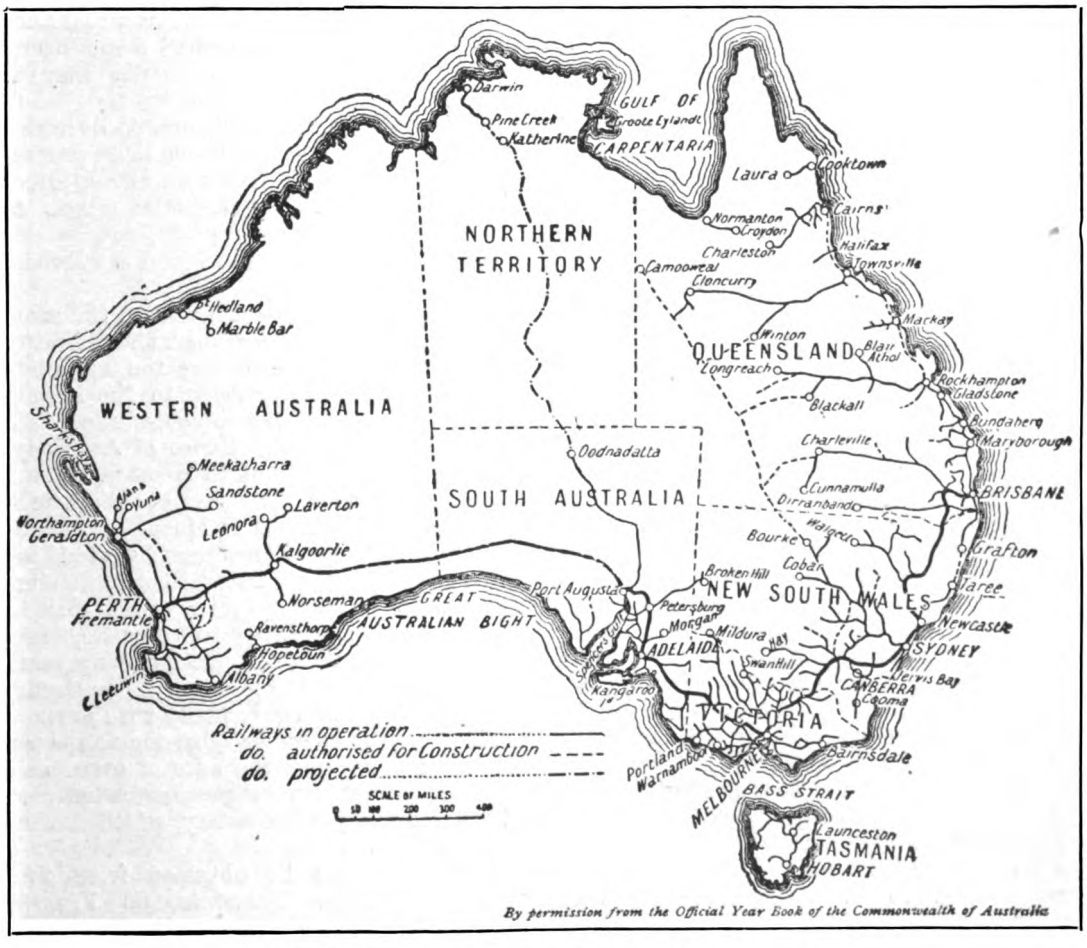
a year round on a farm in order to become thoroughly inured to the different methods and systems of agriculture, and no one should invest money in land without at least a short preliminary experience.

Most of the cultivated land in South Australia is under wheat, and, on an average, a crop of over 11 bushels to the acre is yielded. Artificial fertilisers are very largely used, and in some parts of the State irrigation is being resorted to on an extensive scale. As for land, it may be bought on a system of instalments at about £6 or £8 an acre and good dairy farms at about £10 an acre. For growing wheat an area of at least 500 acres is advisable, and not less than £1 an acre capital is required, in addition to the cost of the land.

The Agent-General for South Australia, 85 Gracechurch Street, London, E.C., will supply current information concerning assisted passages and such matters to intending emigrants.

Queensland occupies the whole of the north-eastern corner of Australia and is nearly twelve times the area of England and Wales. On the Darling Downs, in the south, the climate is delightful nearly all the year round, but some of the other parts are semi-tropical, the heat being intensified by the heavy rains which fall during the summer months.

Queensland is the country of "selectors," or agriculturists who take up land direct from the State. Every month in the different land districts courts are held and large tracts of country declared open for selection. In the case of most farms leases are for a period of 20 years and the rent per acre is one-fortieth part of the purchase price, which must not be less than 10s. an acre, but which is usually more. Within six months of receiving his licence for the land the selector must occupy it, and after five or ten years of personal residence the lessee may make



POLITICAL DIVISIONS AND RAILWAYS OF AUSTRALIA

the land his freehold property upon completing certain payments.

Land is also sold cheaply by auction, and special opportunities for obtaining the freehold of agricultural homesteads not exceeding 640 acres are given to the selector. If he has duly paid his rent of 3d. an acre for a year, spent from 2s. 6d. to 10s. an acre for improvements, and has resided on the land for five years and finally pays a sum which with the rent already paid makes up 2s. 6d. an acre, he is entitled to the freehold.

All this sounds very Utopian, but the youthful emigrant must not become obsessed with the idea that he will at once pack off to Queensland to avail himself of these generous offers of land. Farming in the Antipodes is not the same as farming in Devonshire, and no one should jeopardise even a small capital on a Queensland farm before obtaining hard, personal experience in the State.

Sheep, cattle and horses form the principal industry of Queensland, and the resources of the State are mainly pastoral. Maize is very largely grown and the production of sugar is a vast business which offers excellent opportunities to men with a little capital.

Gold, copper, tin, silver and coal are found in Queensland. The Darling Downs district offers some of the finest land in the world for fruit-growing, dairying or general mixed farming.

Assisted and nominated passages are sometimes granted to approved applicants, and the latest information may be obtained from *The Agent-General for Queensland*, 409 *Strand, London, W.C.*

Western Aust alia is eight times as large as Great Britain and Ireland and possesses three distinct climates. In the south-west the climate is rather like that of Southern Italy; from Carnarvon northwards the rainfall is irregular with hot, dry summers; in the Kimberley districts the climate is tropical with the rainy season in the summer.

Here, again, the opportunities are mostly for farmers and farm workers, but no one should take up land until he has obtained some personal experience of the conditions of agriculture in the State.

Gold is by far the most important product of Western Australia, Coolgardie being the centre of the gold-bearing field, but there is no marked demand for miners, at least not enough to tempt large numbers of emigrants.

Grazing farms may be bought at from **3s.** 9d. per acre upwards, payable by equal instalments spread over twenty years. Homestead farms of 160 acres cost £9 2s. each, which can be paid in two annual instalments.

Camels are much used in the dry districts of this State, and in the southern portion vines and fruits of all kinds flourish. Nearly a million acres of land in this State were cultivated for wheat, oats, and barley in a recent year.

The Agent-General for Western Australia, 15 *Victoria Street, London, S.W.*, will supply details concerning assisted passages and those other matters which directly affect the intending emigrant.

Tasmania is an island, almost the size of Ireland, at the southern extremity of Australia and possesses a most healthy climate. It is a wonderfully fertile country, particularly adapted for fruit-growing, mixed farming, raising cereals and for agriculture generally, whilst there is excellent pasturage for grazing purposes.

First-class farms, with buildings, cost from £15 to £25 an acre, but small farms up to 200 acres are in some parts not easy to secure.

Tasmania contains coal, and is also rich in gold, copper, tin and silver. The production of tin is greater than that of any other Australian State. Tasmania leads also in copper production.

The chief towns on the island are Hobart and Launceston.

The State is governed much on the same principle as the other Australian States. Four ministers, constituting the executive government, are responsible to the legislature, which consists of two bodies, the Legislative Council and the House of Assembly. The Council consists of 18 members elected for six years, who must possess certain property qualifications. The House of Assembly consists of 35 members elected for three years. Anyone natural born or naturalised who has lived for a whole year in Tasmania is entitled to a vote, and women, as has been the case for many years in most parts of the Australian continent, have the right to vote equally with men.

Education is compulsory in the towns for all children between the ages of seven and thirteen, and this very progressive outpost of Empire has one University, which confers degrees.

Particulars can be obtained from *The Agent-General for Tasmania*, 56 *Victoria Street, London, S.W.*, and assisted passages are granted to emigrants in certain circumstances. A. C. M.

BOOK-KEEPING.—V

THE time has now come for us to explain the method of compiling a complete set of books, and the student will be shown how to open the accounts, close them, ascertain profits or losses, capital or deficiency, and prove the accuracy of the results.

Although it is proposed to use separate books for the purchases, sales, and cash, there are certain transactions which cannot very well be entered in these books, the record of which must be kept in the Journal.

Practical Use of the Journal

In the examples which have been given up to the present time, the capital has always been in the form of cash. In practice it is generally made up of cash and other kinds of property. It will be remembered that capital is, broadly speaking, the excess of assets over liabilities, or, in other words, the difference between what a man has and what he owes.

It may be that at the beginning of a trading period, or when he opens a new set of books, he has certain debts owing to him, and certain possessions of his own in addition to cash, but he in his turn is indebted to others. It is only by taking all these items into account that the trader's capital can be ascertained. This is usually done by entering the assets and liabilities in the Journal, preparatory to posting them into the Cash Book or Ledger. When the assets and liabilities are entered in this way in the Journal, they are called "Opening Entries" or "Opening Balances."

By way of illustration let it be supposed that when A. Venture opened his books on May 1st, 19.., his possessions were as follows (*see top of next column*):—

He had cash in hand	£400
His furniture and fittings were valued at	100
The value of goods on hand unsold was	150
J. Hampshire owed him	60
John Buckley owed him	45
Clement Ikin owed him	36 10*s.*

In addition to above, A. Venture himself owed to Henry Holme £73, to James Davies £16, and to Owen Roberts £37.

These make his Opening Balances, and must be entered in the Journal (*see below*).

The assets are taken first, and it will be remembered that these are always debit balances, whilst the liabilities represent balances on the credit side. The difference between the two represents either capital or a deficiency.

The Capital Account is credited because it represents the sum which the business owes to its proprietor, and it is quite clear that it represents the amount by which the assets exceed the liabilities.

Like other Journal Entries previously shown, the above are posted to the Ledger, necessarily on the same side of the Ledger Accounts as they are shown in the Journal. Each item is Dr. "To Balance" or Cr. "By Balance," the amount representing the balances brought forward from a previous set of accounts if such have been kept.

Closing of Accounts In Order to Ascertain Profit or Loss

The account in which the record of gross profit or loss is found is, as already explained, the Trading Account. On the Debit side it contains the stock at the commencement, the Purchases (less returns outwards), and any expenses necessary for the production, or adding directly to the cost, of the goods. Such items as Wages and

JOURNAL

		Dr.			Cr.		
ASSETS :—		£	*s.*	*d.*	£	*s.*	*d.*
Cash	*Dr.*	400	–	–			
Furniture and Fittings	*Dr.*	100	–	–			
Stock	*Dr.*	150	–	–			
J. Hampshire	*Dr.*	60	–	–			
John Buckley	*Dr.*	45	–	–			
Clement Ikin	*Dr.*	36	10	–			
LIABILITIES :—							
To Henry Holme					73	–	–
„ James Davies					16	–	–
„ Owen Roberts					37	–	–
„ Capital Account					665	10	–
	£	791	10	–	791	10	–

Carriage Inwards would be debited to this account: the latter because the amount expended has added to the cost of the goods, and the former because the amount spent represents the value added to the goods purchased. On the credit side are entered Sales (less returns inwards) and stock in hand at the close of the trading period. If the credit side is the greater the excess represents Gross Profit, whilst if the debit side is heavier a loss has been sustained.

With the exception of the value of stock in hand at the end of the trading period, all the items in the Trading Account are transfers from other accounts.

For the present it is proposed to divide the Trading Account into two separate accounts: the first the Trading Account proper, the balance of which represents Gross Profit; the second the Profit and Loss Account, the balance of which represents Net Profit which is transferred to the Capital Account.

The Balance Sheet is a statement of the Assets and Liabilities (including Capital), and represents the balances standing in the books when the accounts are made up.

In order to show more clearly how the accounts are closed and the profit or loss ascertained, a complete exercise will now be worked out.

The trader commences business on June 1st, 19.., and his position is as follows:—

Assets		Liabilities	
Cash	£300	Alfred Denver	£90
Stock ..	£250	Capital	£500
T. Darwin	£40		

His transactions were:—

19..		£	s.	d.
June 2	Paid Alfred Denver ..	60	–	–
„ 3	Bought goods from Alfred Denver	60	–	–
„ 9	Sold goods to T. Darwin	50	–	–
„ 17	Bought goods for cash ..	36	–	–
„ 18	Received from T. Darwin..	20	–	–
„ 21	Paid Rent	10	–	–
„ 23	Paid Wages	9	–	–
		£ 245	–	–
	Stock at finish, £350.			

JOURNAL

			Dr.			Cr.		
			£	s.	d.	£	s.	d.
Assets:—								
Cash	4	2	300	–	–			
Stock	2	2	250	–	–			
T. Darwin	5	5	40	–	–			
Liabilities:—								
To Alfred Denver ..	6	6				90	–	–
„ Capital	1	1				500	–	–
	£		590	–	–	590	–	–

Dr. CAPITAL ACCOUNT (1) Cr.

				£	s.	d.
19.. June 1	By Balance..	1		500	–	–
„ 30	„ Net Profit from P. and L. a/c ..	10		35	–	–
		£		535	–	–

Dr. STOCK ACCOUNT (2) Cr.

19..			£	s.	d.	19..			£	s.	d.
June 1	To Balance	1	250	–	–	June 30	By Transfer to Trading a/c..	9	250	–	–
June 30	To Balance		350	–	–						

Dr. PURCHASES ACCOUNT (3) Cr.

19..			£	s.	d.	19..			£	s.	d.
June 30	To Sundries as P. B.	2	60	–	–	June 30	By Transfer to Trading a/c	9	96	–	–
„ 17	„ Cash	4	36	–	–						
		£	96	–	–			£	96	–	–

SALES ACCOUNT (4)

Dr.			£	s.	d.				£	s.	d.	Cr.
19.. June 30	To Transfer to Trading a/c	9	50	–	–	19.. June 30	By Sundries as S. B.	3	50	–	–	

T. DARWIN (5)

Dr.			£	s.	d.				£	s.	d.	Cr.
19.. June 1	To Balance	1	40	–	–	June 18	By Cash	4	20	–	–	
„ 9	„ Sales	3	50	–	–	„ 30	„ Balance	c/d	70	–	–	
		£	90	–	–			£	90	–	–	
June 30	To Balance	b/d	70	–	–							

ALFRED DENVER (6)

Dr.			£	s.	d.				£	s.	d.	Cr.
19.. June 2	To Cash	4	60	–	–	June 1	By Balance		90	–	–	
„ 30	„ Balance		90	–	–	„ 3	„ Purchase	2	60	–	–	
		£	150	–	–			£	150	–	–	
						June 30	By Balance		90	–	–	

RENT ACCOUNT (7)

Dr.			£	s.	d.				£	s.	d.	Cr.
19.. June 21	To Cash	4	10	–	–	19.. June 30	By Transfer to P. and L. a/c	10	10	–	–	

WAGES ACCOUNT (8)

Dr.			£	s.	d.				£	s.	d.	Cr.
19.. June 23	To Cash	4	9	–	–	19.. June 30	By Transfer to Trading a/c	9	9	–	–	

PURCHASES BOOK (2)

				£	s.	d.
19.. June 3	Alfred Denver (Goods)	6		60	–	–
		Fol.	3	£ 60	–	–

SALES BOOK (3)

				£	s.	d.
19.. June 9	T. Darwin (Goods)	5		50	–	–
		Fol.	4	£ 50	–	–

CASH BOOK (4)

	Receipts		£	s.	d.		Payments		£	s.	d.
19.. June 1	To Balance	1	300	–	–	19.. June 2	By A. Denver	6	60	–	–
„ 18	„ T. Darwin	5	20	–	–	„ 17	„ Goods	3	36	–	–
						„ 21	„ Rent	7	10	–	–
						„ 23	„ Wages	8	9	–	–
						„ 30	„ Balance	c/d	205	–	–
		£	320	–	–			£	320	–	–
June 30	To Balance	b/d	205	–	–						

The following is the Trial Balance for the foregoing, which is prepared immediately the Ledger has been posted from the books of original entry and before any of the accounts have been balanced.

	Dr.			*Cr.*		
	£			£	*s.*	*d.*
Capital				500	–	–
Stock	250	–	–			
Purchases	96	–	–			
Sales				50	–	–
T. Darwin	70	–	–			
Alfred Denver				90	–	–
Rent	10	–	–			
Wages	9	–	–			
Cash (from Cash Book)	205	–	–			
£	640	–	–	640	–	–

credit side the stock on June 30th. The account, when balanced, shows a gross profit of £45, and this amount is carried down as a credit in the Profit and Loss Account. The Rent Account is closed by transferring the amount to the debit of Profit and Loss, whilst the Profit and Loss Account is closed by transferring the balance, which represents Net Profit, to the Capital Account. The personal accounts are thereupon closed, and the balances carried down. The balance sheet is then made out.

If the student will work out the foregoing exercises, carefully reading the explanations, he should have no difficulty in understanding how Profits are ascertained, and how accounts are proved.

Dr. TRADING ACCOUNT (9) *Cr.*

19..			£	*s.*	*d.*	19..			£	*s.*	*d.*
June 30	To Stock (June 1st)	2	250	–	–	June 30	By Sales	4	50	–	–
„ „	„ Purchases	3	96	–	–	„ „	„ Stock (June 30)..		350	–	–
„ „	„ Wages	8	9	–	–						
„ „	„ P. and L. a/c ..	10									
	Gross Profit		45	–	–						
		£	400	–	–			£	400	–	–

Dr. PROFIT AND LOSS ACCOUNT (10) *Cr.*

19..			£	*s.*	*d.*	19..			£	*s.*	*d.*
June 30	To Rent	7	10	–	–	June 30	By Trading a/c	9	45	–	–
	„ Net Profit, transferred to Capital a/c	1	35	–	–						
		£	45	–	–			£	45	–	–

Dr. BALANCE SHEET AS AT JUNE 30TH, 19.. (11) *Cr.*

		£	*s.*	*d.*			£	*s.*	*d.*
LIABILITIES :—					ASSETS :—				
Alfred Denver ..		90	–	–	T. Darwin		70	–	–
Capital		535	–	–	Stock at finish ..		350	–	–
					Cash..		205	–	–
	£	625	–	–		£	625	–	–

In closing accounts, they should be dealt with in the following order, namely, the Trading Account should be opened and the amount of stock on June 1st transferred into it from the Stock Account, which will then be closed.

The Purchases Account, Sales Account, and Wages Account will each be treated in the same way. The Trading Account will be completed by carrying into it on the

Definition of Terms

Interest usually represents a charge made by one person to another for the use of money lent. Sometimes it is charged when payment is overdue.

Depreciation is the falling off in value which assets of various kinds may suffer in the process of wear and tear due to ordinary usage.

F. H.

From a drawing by G. F. Morrell.

ROMAN ROADS IN BRITAIN.

In many parts of the country the magnificent roads made during the Roman occupation (55 B.C.—A.D. 410) have fallen into disuse. Their restoration would be of enormous value to the community in these days of transport problems and heavy motor traffic. Apropos of suggestions that our highways should be nationalised, it is interesting to note that the Roman-made roads in Britain, like the admirable main roads in modern France, were constructed under the central authority (*see pp.* 391 *sqq. and pp.* 396 *sqq.*).

Continued from page 331.

ENGLISH LANGUAGE AND LITERATURE:

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THE DAWN OF FICTION

THE greatest book of the first half of the sixteenth century was Sir Thomas More's *Utopia*. Written in Latin, in 1515–16, it was not translated till 1557, when a delightful rendering, made by Ralph Robynson, preserved all the quaintness and sly humour of the original work. The modern reader who understands the conditions under which Sir Thomas More wrote his immortal book cannot but be as amazed at the author's boldness as he is charmed by his commingling of practical sagacity with prophetic insight.

Trained for public life in the house of Cardinal Morton, More rose without a pause to the highest offices. When he left Oxford and entered as a lawyer, he was already known far and wide as an accomplished scholar. At the age of twenty-one he was a Member of Parliament and Under-Sheriff of London; and although, to use the words of Erasmus, "he tried as hard to keep out of Court as most men try to get into it," he was taken into the King's service, sent to the Continent as an ambassador, made a Privy Councillor, Treasurer of the Exchequer, in 1523 Speaker of the House of Commons, and in 1529 Lord Chancellor.

More's *Utopia*

To More's house came Henry VIII. to talk as friend with friend. Once when the King had placed his hand affectionately on More's shoulder, as he walked and talked with him, someone remarked how much the King loved him.

"Yes," said More, "but if the loss of my head would win His Majesty a castle in France, I should lose it."

When Henry demanded that all Englishmen should acknowledge *his* supremacy in religion, More, who was a consistent Catholic, refused to give the lie to his own heart by lip-service, and, to the astonishment of Europe, was brought to the scaffold.

Utopia, described as "a fruitful and pleasant work on the best state of a public weal," was written nineteen years before More's death. It boldly exposes the social and economic evils of the period, declares that "the commonality choose the King for their own sake and not for his sake," and it outlines reforms that have been coming to pass gradually ever since. Some of the suggestions made in the book are trivial and even absurd, but no book in the language contains more suggestive thought, or, on occasion, a nobler eloquence.

Pulpit Literature

As we approach, and enter, Elizabethan times, with their wonderful extension of human interests, through revived learning, wider travel, growth of curiosity, and expansion for thought and individuality, we find that prose writing begins to follow a variety of lines of interest which since have developed into distinct classifications.

Elyot's *Governour* began a literature of education which has never been very wide, yet is important. Popular preaching introduced a literature of the pulpit, not wholly theological. Curiosity respecting the past developed, very gradually, a spirit of historical inquiry, and the collection of chronicles of widely varying value. Religious controversy led on to partisan history. Translation of old-world biographies suggested modern biography. A new consciousness of style in writing sought expression in literary criticism. The wonderland of travel was revealed in accounts of voyages and discoveries. And the ancient art of story-telling was revived in new experimental forms of fiction.

Each of these developments calls for some

separate notice. Nearly all of them eventually helped to feed the great central literary movement of the period, the development of the drama, which must be the subject of another chapter.

Several distinctive books of lasting interest mark each of the tendencies that have been enumerated. Thus, the literature of the pulpit may be said to begin with Hugh

WOODCUT FROM ASCHAM'S "SCHOLEMASTER," 1571.*

Latimer, whose sermons are reprinted to this day.

Latimer was a Leicestershire man by birth, the son of a yeoman who had no land of his own, but rented a farm for "three or four pound by the year; and tilled it so as to keep half a dozen men." He "had a walk for a hundred sheep," and Latimer's mother milked thirty cows. So Latimer told King Edward VI., when preaching before him, and added that his father had given each of his daughters five pounds when they were married, and had brought them up in godliness. "He kept me to school." added the preacher, "else I had not been able to preach before the King's Majesty now."

The homely straightforwardness of this personal talk is typical of Latimer. He was bold, plain, trenchant, and full of humour. Brought up "as obstinate a Papist as any in England," he began to change, and started on the road to a Protestant martyrdom after taking part in a theological debate at Cambridge. He was far too honest and too courageous to conceal his change of opinion; but his sermons—for he was University preacher—were so practical that the theologians could not readily entangle him. When he was prohibited from preaching at the University, Wolsey licensed him to preach anywhere, and the King (Henry VIII.) made him a royal chaplain. Imprisoned towards the close of Henry's reign, he was released, and became Bishop of Worcester, under Edward VI.; but was imprisoned again by Mary, and went to the stake at Oxford in 1555, at the age of 65, saying to his fellow-sufferer, Bishop Ridley: "Be of good comfort, Master Ridley, and *play the man.*"

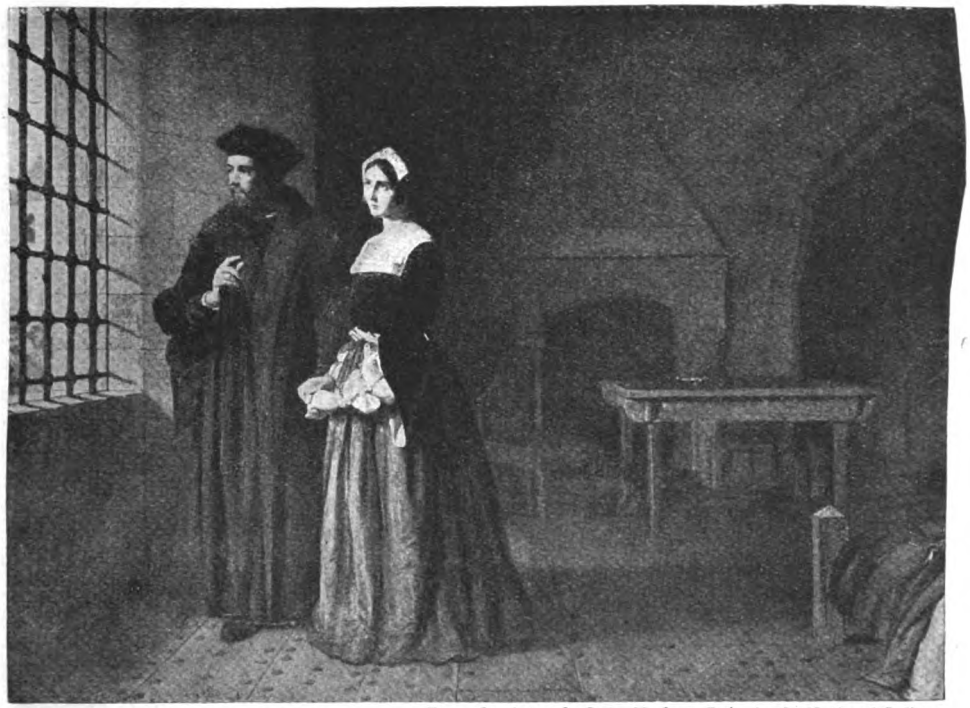
Roger Ascham

Latimer's sermons dealt with real things, and abound in illustrations from the life of the period, so that they have become valuable as sidelights thrown on the customs of the age. They have an English stoutness and sturdy vigour that were continued in the style of his younger contemporary Roger Ascham. Latimer's *Sermon on the Ploughers*, and his *Seven Sermons preached before Edward VI.*, are included in Professor Arber's reprints.

Roger Ascham, a Yorkshireman, educated at Cambridge, was first a tutor there and afterwards became professor of Greek. He attracted much attention by writing a book in dialogue—*Toxophilus*—on archery, a favourite subject also with Latimer. One of its first effects was that it led to archery being taught in some of the public schools, such as Harrow, then being founded. It also brought Ascham a pension from the King. Later, Ascham became tutor to the Princess Elizabeth, between her seventeenth and nineteenth years. As he did not take holy orders he retained public employment under Mary, and was her Latin secretary, though of the reformed faith, and during ten years of Elizabeth's reign was in great favour.

He is now known chiefly for his *Schole-master*, which was begun in 1563, and has

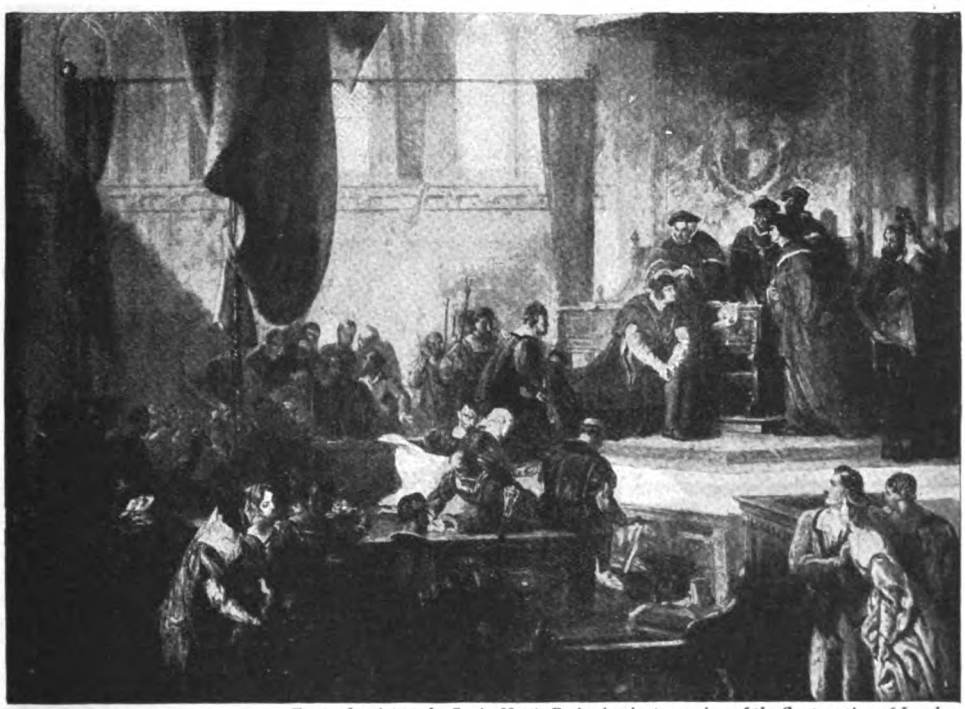
* A tree growing out of an effigy on a tomb, with the Latin motto meaning—"Death hastens on daily, yet virtue will live on after the burial."



From the picture by J. R. Herbert, R.A., in the National Gallery.

SIR THOMAS MORE, AS A PRISONER IN THE TOWER,

sees from his cell window, during one of his daughter's visits, four monks on their way to the scaffold.



From the picture by S. A. Hart, R.A., in the possession of the Corporation of London.

SIR THOMAS MORE RECEIVING A BLESSING

from his aged father, Judge More, at the Court of King's Bench—a duty which Sir Thomas always undertook before taking his seat at the adjoining Court of Chancery.

kept its place into modern times in cheap editions. It was a contribution in favour of the anti-flogging school, which then began to make itself heard in protest against the customary stern treatment of childhood; and it contained a detailed plan for teaching foreign tongues.

Ascham's English is sometimes spoken of as "rugged" by the advocates of a full, flowing, rotund style; but it had the greater advantages of plain strength and unmistakable clearness—qualities much needed when learning had hold of the reins and was driving with a heavy hand.

Thomas Cranmer

Mention should be made, in passing, of Archbishop Thomas Cranmer. Not only did he help to popularise the Bible, but he, chiefly, was responsible for the beautiful cadences of the English Prayer Book. His literary influence was all in favour of smoothness and grace. Though Cranmer was, as has been said, "too fearful about what might happen to him," and often did not "play the man," he "made a good end," and the breadth, falling into pliability, which has weakened his character as an historical personage was an advantage to literary taste.

The sixteenth century was a time when much material for the historian was collected, though at first the industrious antiquarian and preserver of traditions had strange ideas of the relative importance of facts, and indeed of the difference between fact and superstitious hearsay. Here are some of the gleaners:

Robert Fabian, who died in 1512, was a clothier and alderman of London, who wrote a rambling chronicle of English history which merged into notes on London.

John Leland (1506–1552), "King's antiquary" to Henry VIII., toured for six years throughout the country, and wrote an *Itinerary* that makes nine volumes. It is an undigested mass of facts, without the first essential of care for accuracy. It brought its compiler a reputation quite undeserved.

Edward Hall, an enthusiastic Londoner, common serjeant and judge, published, in 1542, a "Chronicle" used by Shakespeare. It was but an elaborate expansion of early records, in "inkhorn terms," as Ascham said, so far as its first chapters were concerned, but it gave some faithful pictures of scenes that were observed personally by the chronicler.

John Stowe, a London tailor, was a worthy and industrious pursuer of such research as was possible in his day. In 1580 he published *The Chronicles of England from Brute to the present year of Christ.* His last work was a *Survey of London* issued in 1598. As a writer, Stowe was commonplace; as a chronicler he endeavoured to be accurate, but had not escaped from the age of credulity.

John Speed, also a London tailor, published, in 1611, a *History of Great Britain.* He had less credulity than Stowe, and a much more florid style.

Raphael Holinshed, who published, in 1578, *Chronicles of England, Scotland and Ireland,* will always be known as the provider of the historical material for nearly all the plays of Shakespeare which recount British history. His *Chronicles* were the work of half a dozen collaborators, but Holinshed, apparently, wrote the larger share. A very valuable part was the *Description of England* prefaced by William Harrison, canon of Windsor, a scholar, patriot, and humorist.

By far the soundest and most scholarly of the Tudor chroniclers was William Camden, the first English writer who could be called an historian in the modern sense. His *Britannia* was written in Latin in 1586, and not translated into English until nearly a quarter of a century later. Camden, an Oxford scholar, was in middle life head master of Westminster School, and, later, Clarenceux King of Arms. His dignified writing was inspired by devotion to Queen Elizabeth and a passionate love of England.

Foxe's *Book of Martyrs*

As the time had not yet come for the writing of impartial history, it is unfair to blame with heat the partisanship of the most popular history of that, or probably any other, day. This was Foxe's *Book of Martyrs.* That vividly written but erratic work was published first in English in 1563. For centuries it may be said to have ranked in popularity with the Bible. Indeed, within eight years after its publication, Convocation ordered that it should be placed in every church.

John Foxe was born at Boston in 1516, educated at Oxford where he became a tutor, and lived long abroad. The *Book of Martyrs* was first published abroad in Latin.

As a whole-hearted Puritan and open enemy of Catholicism, Foxe was not sufficiently careful to sift the evidence offered to him. He was too ready to believe that which chimed with his own belief. As a writer he had great gifts, and his power of vivid

narration has rarely, if ever, been surpassed. His book dyed the English mind for ten generations.

The first genuine English biography was George Cavendish's *Life and Death of Thomas Wolsey*. Few books have had a more romantic origin and history. Cavendish was a country gentleman of Suffolk, who married a niece of Sir Thomas More. A strong desire to see the lives of the great at close quarters took him into Wolsey's service, where his wishes were too abundantly gratified. He became the Cardinal's gentleman usher. His position enabled him to introduce his brother William to Court society, and, by marrying the ambitious "Bess of Hardwick," the brother became the founder of the Devonshire family, with other noble offshoots.

George served the proud Cardinal with a splendid fidelity. He was present when Wolsey died, a Leicester Abbey, in 1530, and recorded his memorable lament: "If I had served my God so diligently as I have done the King, he would not have given me over in my grey hairs."

It was Cavendish who reported the death to Henry VIII. When the King asked him what he wanted for himself, he replied that all he needed was a cart and horse to take his goods home into Suffolk. Then the King gave him six horses and a cart from Wolsey's stables, adding five marks for expenses, ten pounds for arrears of wages, and twenty pounds as a present. A commission which examined Cavendish on Wolsey's affairs and death, pleased by his bearing, complimented him on being "a just and diligent servant."

[From the painting by Sir George Hayter.

HUGH LATIMER PREACHING IN THE OPEN AT OLD ST. PAUL'S.

His sermons to Edward VI. are reprinted to this day. In 1555, at the age of 65, Latimer, in company with Bishop Ridley, was martyred at Oxford.

More than satisfied with what he had seen of the lives of the great, George Cavendish retired to a quiet country life in Suffolk, and busied himself with writing a biography, which, in its way, is a masterpiece. The book was well known to the later chroniclers, and there is no doubt that Shakespeare read it before writing his *Henry VIII.*

With dignity, and without prying, George Cavendish takes us behind the scenes of a great life. As an illustration of his style we quote his description of Wolsey's reception by the Earl of Shrewsbury, at Sheffield Manor, on the fateful journey under arrest which ended in death at Leicester:

When we came into the park of Sheffield, nigh to the Lodge, my Lord of Shrewsbury, with my Lady, and a train of gentlewomen, and all other his gentlemen and servants, stood without the gates to attend my Lord's coming. At whose alighting the Earl received him with much honour, and embraced my Lord, saying these words:

"My Lord," quoth he, "your Grace is most heartily welcome unto me, and I am glad to see you here in my poor Lodge, and much more glad if ye had come after another sort."

"Ah, my gentle Lord of Shrewsbury," quoth my Lord, "I heartily thank you, and I do rejoice that my chance is to come into the custody of so noble a person. And howsoever mine accusers have used their accusations against me, this I know, and before your Lordship and all the world I do protest, that my demeanour and proceeding have always been both just and loyal towards my Sovereign and Liege Lord."

"I doubt not," quoth my Lord of Shrewsbury, "of your truth, and therefore be of good cheer and fear not, for I will not receive you as a prisoner, but as the King's true and faithful subject. And here is my wife come to salute you," whom my Lord kissed, with his cap in his hand, bare-headed, and all the other gentlewomen, and took the Earl's servants by the hand, as well gentlemen as yeomen.

This done these two Lords went into the Lodge arm in arm.

Among translations, in Elizabethan times, which have retained their importance, and at once were a literary power, must be mentioned Sir Thomas North's *Plutarch's Lives* (1579) and John Florio's *Essays of Montaigne* (1603), both of which were read and used by Shakespeare. Their interest as translations supplements the high value of the original works.

Books of Travel

Literary criticism first appeared in Sir Philip Sidney's *Apology for Poetry*, written in 1581, and in William Webbe's *Discourse of Poetry*, published in 1586. Both these books were too soon, so far as English poetry was concerned; for it had not reached the stage at which it would bear analytical criticism. Only Chaucer, Sackville, and Spenser could be brought into the lists with the ancients. Sidney's *Apology*, written in answer to a Puritanical pamphlet abusing poetry at large, and dedicated, without permission, to himself, was merely a general defence.

English poetry, in fact, had not yet found its feet.

The travel literature of the Elizabethan period has laid all succeeding generations under a deep obligation. Through Richard Hakluyt we know what England did during the period when, by travel, Creation was "widening in man's view." Hakluyt was of Welsh extraction, born in London, educated at Westminster School and then at Oxford, where he began to lecture on geography. After spending much time as a chaplain abroad, studying always the story of the early voyagers, he became Chaplain of the Savoy and finally Archdeacon of Westminster.

He published, in 1589, *The Principal Navigations, Voyages, Traffiques and Discoveries of the English Nation*, and i has been said that to him more than to anyone England was indebted for her American possessions. He was not only a tireless collector of information, but a sound editor and vigorous writer, as a glance at his Prefaces and Introductions will show.

It was during this wonderful period of intellectual stimulation, the Elizabethan epoch, that we have the first tentative efforts of the prose fiction which has formed so large a part of the modern literary output. Robert Greene, Thomas Lodge, and Thomas Nash, who all helped to swell the great tide of the drama on which William Shakespeare was carried to immortal fame, were also novelists.

A Forecast of Defoe

Greene's romance *Pandosto* was the nucleus around which Shakespeare formed his *Winter's Tale*. On one of Lodge's stories, Shakespeare based his *As You Like It*. Nash's *Jack Wilton*, the adventures abroad of a rascally English page, was a forecast of Defoe. All these attempts were crude, but they were the continuation, in fiction, of the movement that was begun by Sir Philip Sidney in his *Arcadia*, and by John Lyly in his *Euphues*, and with these books they give the prose tale a distinct place in our literature.

It is not easy to forgive Lyly for the harm he did in popularising an inflated style, that will not tell a plain tale plainly, and tortures language into similes which, besides being absurdly elaborate, are often false. The pompous, euphuistic style was at once caricatured by Shakespeare, and has been derided ever since.

Sir Philip Sidney's *Arcadia*, left unfinished, was, in prose, a counterpart to Spenser's *Faerie Queene* in poetry. That is to say, the author wandered at will through a world of his own fancy, without a plan, but surrounded with romance and poetry.

The influence of Lyly and of Sidney in prose was antagonistic to the influence of such writers as Tyndale, Cranmer, Malory, Latimer, Foxe, Cavendish, and Ascham, who all sought first after clarity, and avoided the elaboration that obscures. J. D.

SPECIAL SUBJECTS

No. 2.—THE STORY OF TRANSPORT

LOOKING back into the mists of the past, the greatest world nations have all been transport pioneers. One has only to consider the road- and bridge-building proclivities of the Romans to realise this, or the merchant shipping of the Spaniards in our own Elizabethan times.

More recently, countries that have been slow in the development of railways, roads, or waterways have been left high and dry by the flowing tide of commerce.

So far as Great Britain is concerned, her commerce and her transport have risen hand in hand until together they have headed the world. The pioneer of the locomotive, Britain has covered the surface of the earth with railways, equipping them with both capital and engineering skill. In the adapting of mighty rivers of the continents to transport this nation has led the way, just as it did in the creating and holding of the blue ribbon of the Atlantic.

Bridging the Atlantic

It is a far cry from the time when a fast man-o'-war sailed from Great Britain to America in 60 days, to that epoch-making event when the great wastes of water were navigated by direct aeroplane flight in 16 hours. In between, we may visualise the first ship with steam engines as auxiliary power that made the passage in 28 days; the first steamship proper, equipped with paddle-wheels, that took 23½ days over the journey; the *Great Britain*, the earliest screw-propelled liner, which crossed in 16 days; the ill-fated *Lusitania*, with turbines, ploughing her way over in 5 days; and the British airship that, from land to land, covered the distance in 75 hours.

Yet the Atlantic crossing, vital as a link betwixt the Old World and the New, is only a phase in the story of our transport; for in the make-up of this vast subject there are to be considered not only our ships and aeroplanes but also the roads, railways, tramways, and inland water routes.

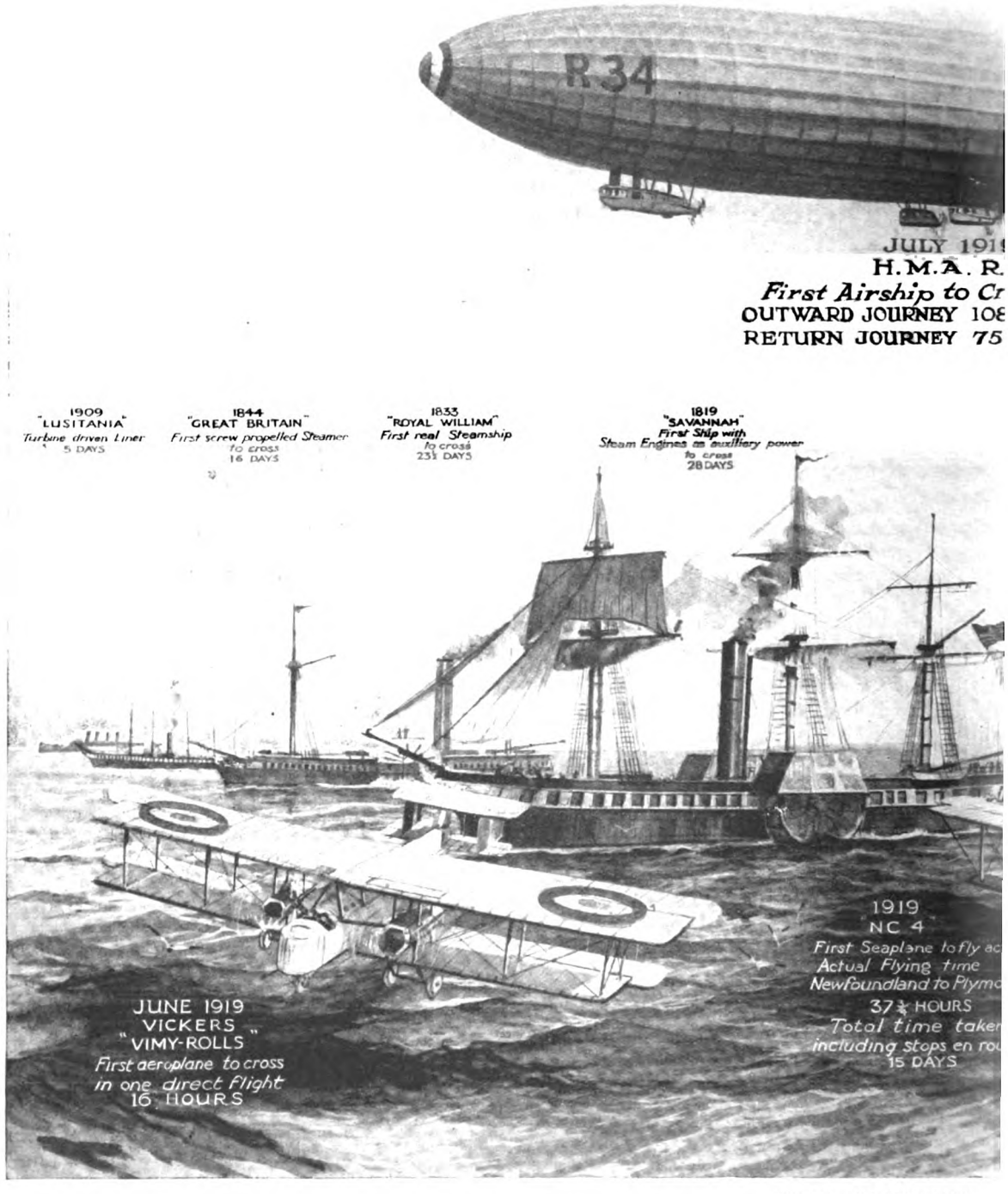
So far as our home railways are concerned, they were formerly manipulated by a considerable number of small companies. In the course of time, however, the number of separate corporations was lowered until now there are in the United Kingdom only 25 main companies.

The capital invested by shareholders in these companies amounts to a colossal sum exceeding 1,350 millions of pounds sterling, and in a recent year the receipts exceeded 154½ millions and the expenses 102 millions; 1,450 millions of passengers were carried (exclusive of season ticket holders), and goods to a total weight of 568 millions of tons. The total number of miles of railway open for traffic in the United Kingdom is about 24,000.

British Railway Enterprise

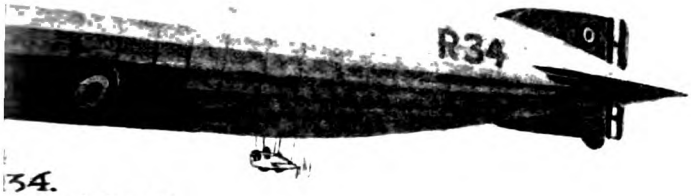
In the entire world there are about 600,000 miles of railways, and of this total the United States of America owns 338,000. On British territory alone there are over 120,000 miles of railways, and some 65,000 miles on other territory are actually owned and worked by British companies.

Of the great English railway companies that run into London there are nine, not counting the purely metropolitan concerns. These are the Great Central (the last line to carry its system as far as London), the London and North Western (the largest company from the point of view of capital issued), the Great Western (with the greatest length of line of any single company, approximately 3,000 miles), the London and South Western, the London, Brighton and South Coast, the South Eastern (over whose line the bulk of the overseas War traffic was carried), the Great Eastern (formerly the Eastern Counties Railway), the Great Northern (which only runs to a point a few yards north of Doncaster, where technically it joins with the North Eastern), and the Midland—the last-named built originally as a coal-carrying line and only adapted for passenger traffic subsequently, though it is now the third longest line in the United Kingdom.



FROM COLUMBUS

A pictorial diagram showing how, during the last five hundred years, the inventiveness, resourcefulness, what new chapters to the story of transport will



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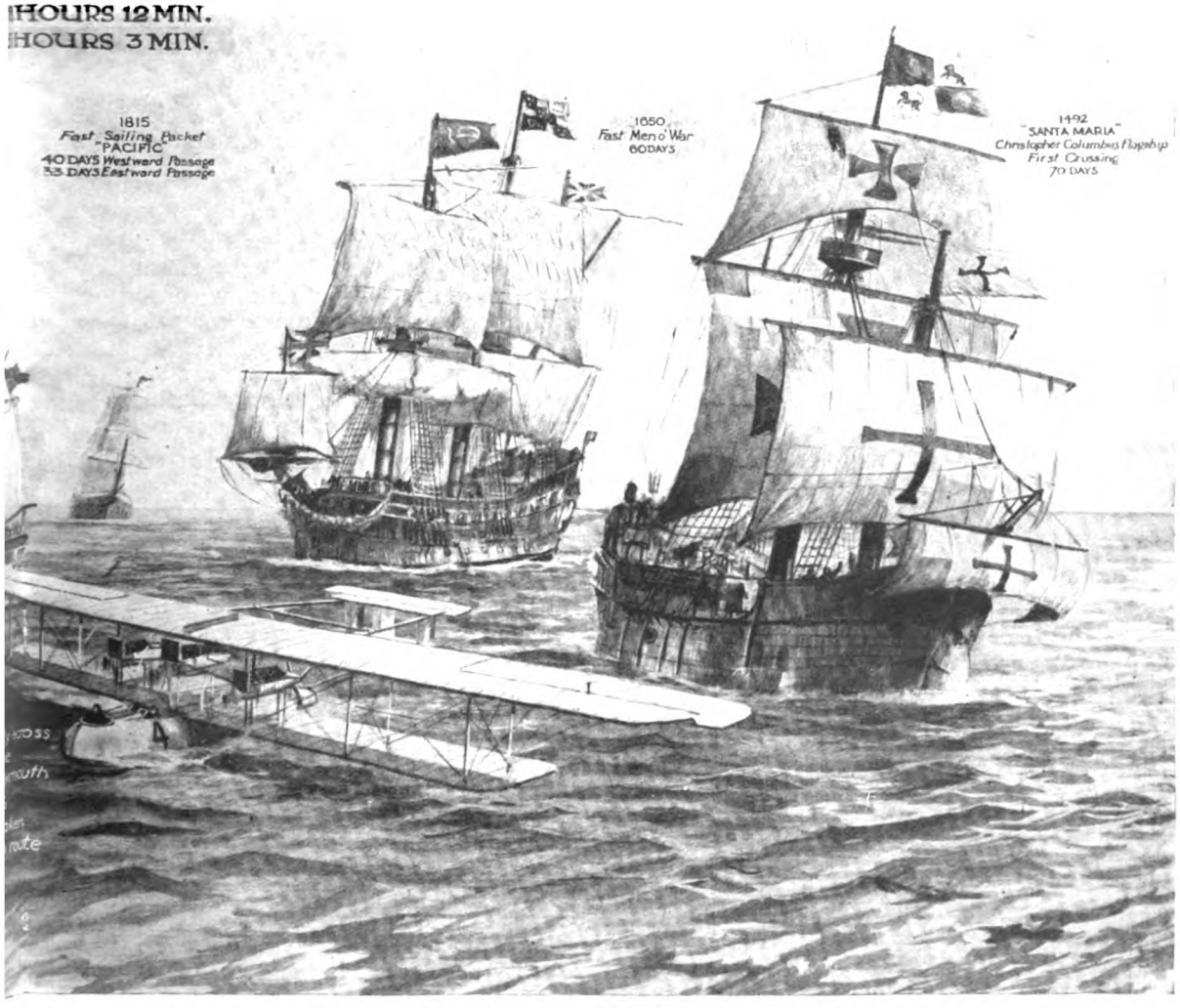
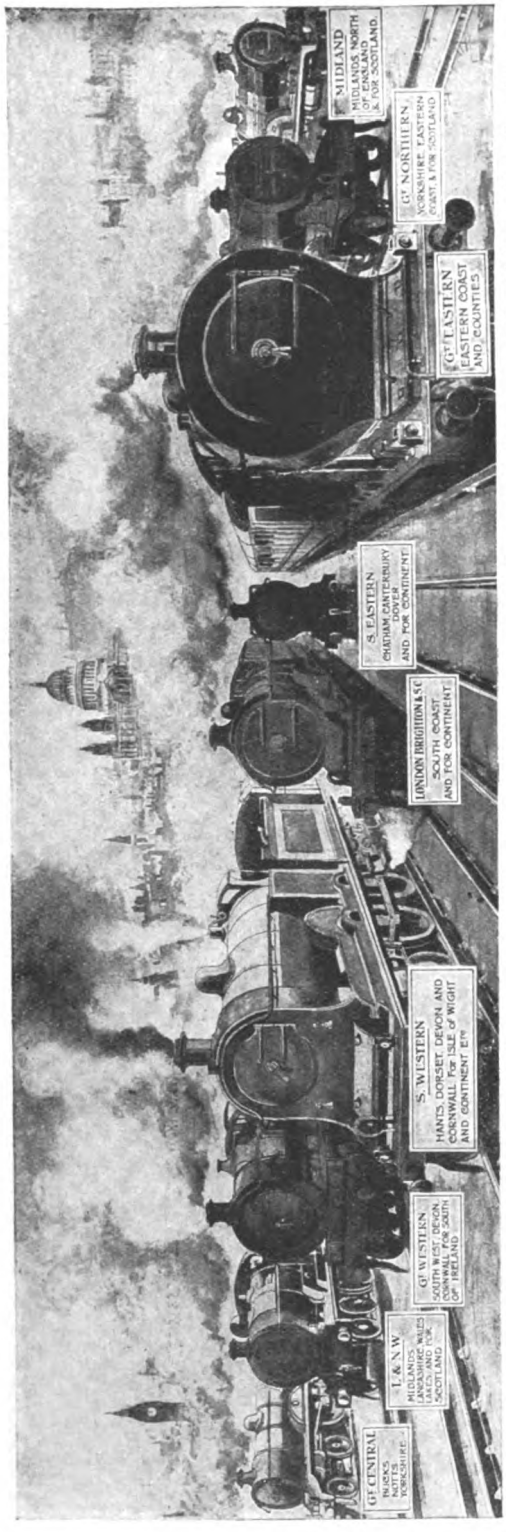


TO ALCOCK.

and daring of man have steadily brought the New World nearer and nearer to the Old. And the future—the airship add during the next five hundred years?



A pictorial diagram illustrating the activities of the nine great railways (other than purely metropolitan systems) which run into London.

So far as our tramways go they represent an important portion of our transport, and at least 80 millions of pounds is invested in the various tramway companies, which, in a recent year, showed receipts of 15 millions and expenses of 10 millions for the carriage of 3,426 millions of passengers. There are nearly 3,000 miles of tramways in the United Kingdom, but by many experts the opinion is expressed that motor omnibuses and trackless cars are likely in the near future to hold such a sway that materially large increases in the track mileage are hardly to be anticipated.

Transport by canal is one of the oldest forms of inland traffic, and the Chinese were the masters not only of canal systems but also of locks many centuries ago. So far as Europe is concerned, Italy may be regarded as the home of the canal; though, latterly, Holland has made wonderful strides in this direction, and the 100-ton barge, propelled by a motor little larger than a domestic sewing-machine, is now very common on the Dutch waterways.

Canals and Waterways

In the United Kingdom we have nearly 5,000 miles of canals, of which 1,363 miles are owned or controlled by railway companies. This curious occurrence was brought about by the fact that the so-called "Bridgwater" canals were nearing completion at the precise time when the railway boom commenced. There was considerable opposition to the coming of the iron road, people maintaining that the new canals would carry all the internal traffic necessary; and it was for self-preservation that the railway companies were forced to buy out the canals. As a matter of fact, nearly 50 millions sterling represent the capital of our canal companies. In a recent year their expenditure was £1,891,000, and their receipts £2,680,000, 43 million tons of merchandise being carried.

The Manchester Ship Canal has a total length of 36 miles and connects Manchester with the Mersey, and a further scheme is afoot for making Nottingham an inland port by canalising the river Trent. That transport by canal will largely develop in the near future there can be little doubt. For heavy, slow traffic there is nothing cheaper, and barges equipped with small internal combustion engines are likely to revolutionise the present antiquated system of tow-horses.

There is not an industry that is not affected by transport, and it is hardly to be wondered at that the so-called "Triple

Industrial Alliance" includes, besides the Miners' Federation, the National Union of Railwaymen (about 300,000 members) and the National Transport Workers' Federation (with over a quarter of a million members). As a matter of fact, though, these figures represent but a portion of those employed in transport at home, for our railways give occupation to far more than half a million workers; our inland and coastal water trade employs another 150,000, and the carrying and cartage concerns have nearly as many workers on their pay-rolls.

Since the War, during which practically the whole of the transport in the field was carried by 30-cwt. and 3-ton motor lorries, the tendency for our roads to be used more and more for the haulage of merchandise has been most marked; and, to some extent owing to the high price of coal, road transport must inevitably increase, particularly should oil fuel be worked on extensive lines at home.

The Channel Tunnel

So much for our purely domestic transport. That goods will be transported freely by airship and also that aeroplanes will figure in the task there can be but little doubt, more especially for the carriage of perishable articles. And when it is considered that seven days in every week not fewer than 27,000 milk churns alone are handled in the metropolis it is obvious how airships, given a central landing-place, could revolutionise the transport of this one vital commodity.

Channel ferries we have now, and tunnels both to Ireland and to France are in contemplation, but the real romance of our transport lies in our mercantile shipping. In a recent year, for the transporting of passengers and goods, there were under the British flag nearly 13,000 steamers, representing more than 19,000,000 gross tons, and 8,000 sailing ships, aggregating 864,000 tons. And to work this shipping nearly 300,000 seamen were employed.

Truly Great Britain has led the world in the evolution of modern transport of every kind.

Moreover, a glance at any shipping map of the world will afford ample proof of the amazing ramifications of our mercantile marine. There is scarcely a trade route in the world over which our steamers do not ply, and we are carriers of passengers and goods for every other nation.

Approximately, there are in the mercantile navies of the world about seventy-five individual companies each of which owns not less than 100,000 gross tons of steamships. Of these nearly fifty are British concerns.

To mention a few of these British steamship owners whose respective fleets aggregate over 100,000 tons—there are the British India Steam Navigation Co.; the Peninsular and Oriental Steam Navigation Co.; the White Star; "Blue Funnel" Line; Ellerman Lines; Furness, Withy and Co.; Cunard; Elder, Dempster and Co.; Union-Castle Line; Royal Mail S.P. Co.; Harrison; Clan; Leyland; Union S.S. Co. of New Zealand; Wilson; Lamport and Holt; Pacific Steam Navigation Co.; Allan; Prince; New Zealand Shipping Co.; Canadian Pacific Railway; Moor Line; China Navigation Co.; Orient Steam Navigation Co., and many others.

In a recent year there were in the world approximately 600 steamers exceeding 7,000 tons each, and of these Great Britain owned more than one-half. The highest day's run of 676 knots made by the *Mauretania* of the Cunard Line has never been equalled, and this vessel's western passage of the Atlantic in 4 days 10 hours 41 minutes at an average sea speed exceeding 26 knots per hour has not been assailed.

Internal Combustion Engines

And, just as a British steamer was the first to cross the Atlantic, so is our mercantile marine well to the front in the construction of vessels propelled by oil fuel. So long ago as 1911 a ship of nearly 1,200 tons gross was fitted with heavy oil engines, and it proved exceedingly satisfactory both as regards economy and reliability.

That ocean transport will in time be metamorphosed by the coming of the internal combustion oil-engine there can be little doubt, and this statement is amply proved by the fact that there are on *Lloyd's Register* no fewer than 60 vessels so fitted. And not only are heavy oil engines adaptable to the propulsion of ocean-going vessels, but it is also in the driving of smaller coastal ships and barges that they have such an important future.

So far as the production of shipping goes—by no means the least interesting aspect of the story of transport—the Clyde is easily our greatest shipbuilding centre. It is followed by the Tees and Hartlepools and then by the Tyne. And not only is the Clyde to the forefront with steamers, but in a recent year it built 40 sailing-ships of a total of nearly 12,000 gross tons.

Continued from page 336.

HISTORY:

Contributors:—J. A. Brendon, B.A. (Oxon.), F.R.Hist.S.; F. Collinson, F.R.Hist.S.; T. P. Evans, B.A. (Oxon.); James A. Manson; L. Stampa, M.A. (Oxon.); and J. B. Sterndale-Bennett.

BRITAIN'S STORY.—I

[*The introductory chapter to* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

NOTHING in the early existence of Britain indicated the greatness which she was destined to attain.

Her inhabitants, when first they became known to the Tyrian mariners, were little superior to the natives of the Sandwich Islands. She was subjugated by the Roman arms; but she received only a faint tincture of Roman arts and letters. Of the western provinces which obeyed the Cæsars, she was the last that was conquered, and the first that was flung away. No magnificent remains of Latin porches and aqueducts are to be found in Britain. No writer of British birth is reckoned among the masters of Latin poetry and eloquence.

Barbarous Islanders

It is not probable that the islanders were at any time generally familiar with the tongue of their Italian rulers. From the Atlantic to the vicinity of the Rhine the Latin has, during many centuries, been predominant. It drove out the Celtic; it was not driven out by the Teutonic; and it is at this day the basis of the French, Spanish, and Portuguese languages. In our island the Latin appears never to have superseded the old Gaelic speech, and could not stand its ground against the German.

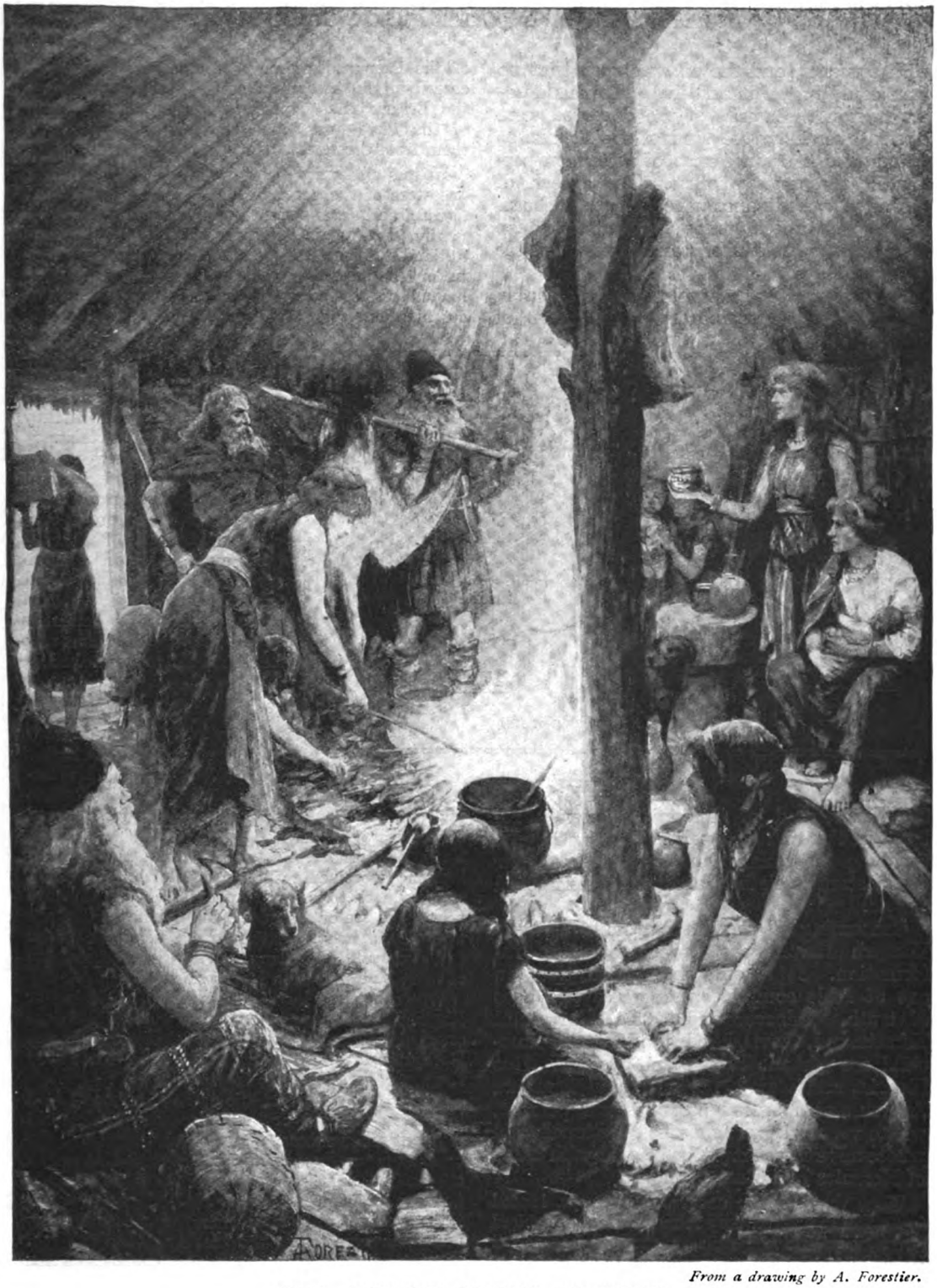
The scanty and superficial civilisation which the Britons had derived from their southern masters was effaced by the calamities of the fifth century. In the continental kingdoms into which the Roman Empire was then dissolved, the conquerors learned much from the conquered race. In Britain the conquered race became as barbarous as the conquerors.

All the chiefs who founded Teutonic dynasties in the continental provinces of the Roman Empire, Alaric, Theodoric, Clovis, Alboin, were zealous Christians. The followers of Ida and Cerdic, on the other hand, brought to their settlements in Britain all the superstitions of the Elbe. While the German princes who reigned at Paris, Toledo, Arles, and Ravenna listened with reverence to the instructions of bishops, adored the relics of martyrs, and took part eagerly in disputes touching the Nicene theology, the rulers of Wessex and Mercia were still performing savage rites in the temples of Thor and Woden.

An Age of Fable

The continental kingdoms which had risen on the ruins of the Western Empire kept up some intercourse with those eastern provinces where the ancient civilisation, though slowly fading away under the influence of misgovernment, might still astonish and instruct barbarians, where the court still exhibited the splendour of Diocletian and Constantine, where the public buildings were still adorned with the sculptures of Polycletus and the paintings of Apelles, and where laborious pedants, themselves destitute of taste, sense and spirit, could still read and interpret the masterpieces of Sophocles, of Demosthenes and of Plato.

From this communion Britain was cut off. Her shores were, to the polished race which dwelt by the Bosporus, objects of a mysterious horror, such as that with which the Ionians of the age of Homer had regarded the Straits of Scylla and the city of the Læstrygonian cannibals. There was one province of our island in which, as Procopius had been told, the ground was covered



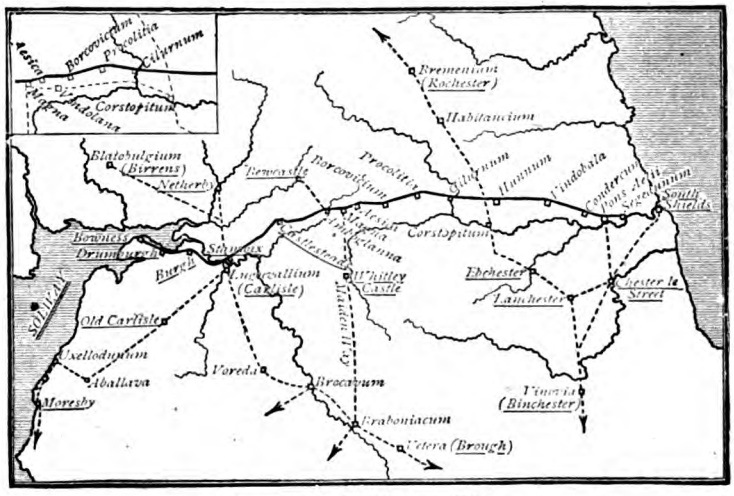
From a drawing by A. Forestier.

THE ANCIENT BRITON AT HOME.

An interesting reconstruction of the interior of a hut of the Lake Village, built on an artificial island near Glastonbury. The Lake Village belongs to the period immediately preceding the Christian era. The drawing shows a rough tree-trunk table, a wooden pail with bronze bands and earthenware pots —characteristic furniture of the age. Meat may be seen hanging from the central pole.

with serpents, and the air was such that no man could inhale it and live. To this desolate region the spirits of the departed were ferried over from the land of the Franks at midnight. A strange race of fishermen performed the ghastly office. The speech of the dead was distinctly heard by the boatmen: their weight made the keel sink deep in the water; but their forms were invisible to mortal eye.

Such were the marvels which an able historian, the contemporary of Belisarius, of Simplicius, and of Tribonian, gravely related in the rich and polite Constantinople, touching the country in which the founder of Constantinople had assumed the imperial purple.



MAP OF HADRIAN'S WALL.

Concerning all the other provinces of the Western Empire we have continuous information. It is only in Britain that an age of fable completely separates two ages of truth. Odoacer and Totila, Euric and Thrasimund, Clovis, Fredegunda and Brunechild are historical men and women. But Hengist and Horsa, Vortigern and Rowena, Arthur and Mordred are mythical persons, whose very existence may be questioned, and whose adventures must be classed with those of Hercules and Romulus.

When the Romans, under Julius Cæsar, landed in Britain in 55 B.C., they found the land inhabited by very primitive people, a race of barbarians living in mud huts and painting their bodies as various savage communities do even at the present time.

The complete subjugation of Britain by the conquerors of the Western world did not take place until the latter part of the first Christian century, and thenceforward, for more than three hundred years, the history of Britain is part of the history of the Roman Empire. This foreign subjugation ceased in the early part of the fifth century, and the Britons then found themselves at the mercy of the Picts and Scots who poured down upon them from the north.

In this extremity they appealed for help to the ancestors of the present English race—the *Angles*, *Saxons*, and *Jutes*—branches of the great Teutonic family, dwelling in Schleswig, in Holstein, and in Jutland. About A.D. 450 a body of these strangers, under the legendary chiefs Hengist and Horsa, landed on the coast of the Isle of Thanet. In combination with the Britons they defeated the Picts and Scots in a great engagement in Lincolnshire; but it was not long before they proved a very much more dangerous foe than those whom they had been called in to resist.

Quarrels arose between the Northmen and the Britons, and the Saxons finally turned their arms upon, and set about to conquer, the islanders. The work of conquest, however, was no easy task. The Britons resisted with immense obstinacy and courage, and two centuries elapsed ere the English race established its predominance.

The Heptarchy

The Anglo-Saxons, on arriving in Britain, found a country which in many parts was highly cultivated, and which had received the stamp of Roman civilisation. But during the struggle that followed this civilisation was lost. London, Verulam, Bath, York, and other cities, which with Roman privileges had received something of Roman splendour, were reduced to miserable ruins; the arts of peace were forgotten or degraded; and the native Britons were almost wholly exterminated except in Wales and Cornwall, and along the north-western shores of what had once been Roman Britain.

When settled by the Northmen, Britain, or England as it came to be called, was divided into seven kingdoms—Kent, Sussex, Wessex, Essex, Northumbria, East Anglia, and Mercia—known by the general name of the *Heptarchy*.

During the time that the seven kingdoms lasted in a state of more or less independence, war was frequent among them, and the development of the country naturally was checked by what Milton has stigmatised as those "wars of kites and crows, flocking and fighting in the air." None the less, these were not futile strivings; the various English kingdoms were taking the best way they knew of settling which was the most worthy to fulfil the trust of making England a nation.

To bringing about this end the Christian Church proved an effective ally. Her authority was an undivided force proceeding from a single centre. Her organisation covered the whole land. Gently, therefore, she drew the separate communities together, made the idea of unity familiar, and fostered

a vague longing for political union, though it was not until 827, on the eve of the Danish invasions, that the whole country at last became one—under the rule of Egbert, King of Wessex.

The conversion of the English to Christianity was first undertaken by Pope Gregory the Great. The story runs that the Pope, greatly impressed by the appearance of some English youths whom he had seen exposed for sale in the slave market at Rome, forthwith sent the Abbot *Augustine* and a band of monks to preach the gospel in their land.

The missionaries landed in 596 on the very spot in the Isle of Thanet where Hengist and Horsa had landed in 450, and rapidly converted Kent to Christianity. The new religion then spread to Northumbria, and gradually throughout the country. Yet the old pagan faith died very hard, and there were many reactions in its favour before finally it disappeared.

The most serious of these was headed by Penda, King of Mercia—a redoubtable champion of paganism.

The work of St. Augustine was largely carried on by missionaries from Ireland brought to Northumbria by King Oswald, who succeeded to the throne in 634. And throughout the middle part of the seventh century, Christianity, represented by Northumbria, and paganism, championed by Penda, maintained a terrible contest.

Though victorious at first, Penda sustained a great defeat near Leeds in the year 655. From that time forth the cause of the older faith was lost, and the question that now remained to be settled was as to the form which the people's Christianity should take.

The Irish monks, who had played so important a part in reconverting the English people, acknowledged but little dependence on the See of Rome. But among the English Christians were some who determined that the claims of Rome should not be set aside. Accordingly, by the order of Osway, King of Northumbria, a great council was held at Whitby to settle the matter in dispute; and it was finally decided that the English Church should acknowledge the Church of Rome.

The conversion of the Saxon colonists to Christianity was the first of a long series of salutary revolutions. It is true that the Church had been deeply corrupted both by that superstition and by that philosophy against which she had long contended, and over which she had at last triumphed. She had given a too easy admission to doctrines borrowed from the ancient schools, and to rites borrowed from the ancient temples. Roman policy and Gothic ignorance, Grecian ingenuity and Syrian asceticism, had contributed to deprave her.

Yet she retained enough of the sublime theology and benevolent morality of her earlier days to elevate many intellects and to purify many hearts.

Some things also which at a later period were justly regarded as among her chief blemishes were, in the seventh century, and long afterwards, among her chief merits. That the sacerdotal order should encroach on the functions of the civil magistrate would, in our time, be a great evil. But that which in an age of good government is an evil may, in an age of grossly bad government, be

From the mural painting at Wallington: by permission of the Rt. Hon. Sir G. O. Trevelyan, O.M., LL.D.

BUILDING THE WALL.

The fortified wall, 80 miles long, across the north of England, "to divide the barbarians and the Romans," was a great engineering feat initiated by the Emperor Hadrian during his visit to Britain (A.D. 120–1).

a blessing. It is better that mankind should be governed by wise laws well administered, and by an enlightened public opinion, than by priestcraft: but it is better that men should be governed by priestcraft than by brute violence, by such a prelate as Dunstan than by such a warrior as Penda.

A society sunk in ignorance, and ruled by mere physical force, has great reason to rejoice when a class, of which the influence is intellectual and moral, rises to ascendancy. Such a class will doubtless abuse its power: but mental power, even when abused, is still a nobler and better power than that which consists merely in corporeal strength.

We read in our Saxon chronicles of tyrants who, when at the height of greatness, were smitten with remorse, who abhorred the pleasures and dignities which they had purchased by guilt, who abdicated their crowns, and who sought to atone for their offences by cruel penances and incessant prayers.

Morals and Muscles

These stories have drawn forth bitter expressions of contempt from some writers who, while they boasted of liberality, were in truth as narrow-minded as any monk of the dark ages, and whose habit was to apply to all events in the history of the world the standard received in the Parisian society of the eighteenth century. Yet surely a system which, however deformed by superstition, introduced strong moral restraints into communities previously governed only by vigour of muscle and by audacity of spirit, a system which taught the fiercest and mightiest ruler that he was, like his meanest bondman, a responsible being, might have seemed to deserve a more respectful mention from philosophers and philanthropists.

The same observations will apply to the contempt with which, in the eighteenth century, it was fashionable to speak of the pilgrimages, the crusades, and the monastic institutions of the middle ages.

The Crusading Spirit

In times when men were scarcely ever induced to travel by liberal curiosity, or by the pursuit of gain, it was better that the rude inhabitant of the North should visit Italy and the East as a pilgrim than that he should never see anything but those squalid cabins and uncleared woods amidst which he was born. In times when life and when female honour were exposed to daily risk from tyrants and marauders, it was better that the precinct of a shrine should be regarded with an irrational awe, than that there should be no refuge inaccessible to cruelty and licentiousness. In times when statesmen were incapable of forming extensive political combinations, it was better that the Christian nations should be roused and united for the recovery of the Holy Sepulchre than that they should, one by one, be overwhelmed by the Mahometan power.

[From the picture by S. B. Carlill.

ST. AUGUSTINE PREACHING TO THE SAXONS.

Sent to Britain by Pope Gregory the Great, St. Augustine landed in the Isle of Thanet in A.D. 596, and speedily converted the people of Kent to Christianity.

Continued from page 353.

SCIENCES:

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CHEMISTRY.—VII

The Combustion of Hydrogen.—THE flame of pure hydrogen burning from a platinum jet in a dust-free atmosphere is nearly invisible. The flame is a very hot one, as can be seen when a platinum wire is held in it; the wire is almost immediately raised to a white heat.

What happens when hydrogen burns?

We know that burning substances unite with the oxygen from the air and form oxides. Therefore, we may confidently expect hydrogen to do the same.

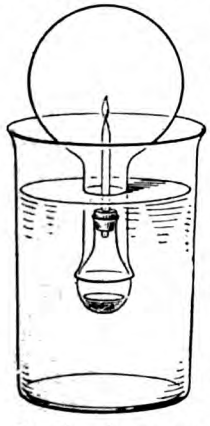


Fig. 8.—Apparatus for ascertaining if burning hydrogen combines with atmospheric oxygen.

Experiment XXI.—*To find out if burning hydrogen combines with atmospheric oxygen.*

Some zinc and dilute acid are put into a small flask, which is then closed with a bung through which passes a glass tube drawn out to a jet at its upper extremity. When the air has been expelled the hydrogen is ignited and the jet introduced into the neck of a 2-litre flask turned upside down. The lower part of the apparatus is then immersed in water contained in a large beaker. A few bubbles of expanded air will escape through the water which will soon begin to rise.

Directly the hydrogen flame is extinguished, the small flask is removed and the large flask is cooled by swirling the water in it round and round. A considerable amount of water will now have entered it. A large cork is fixed in its neck and it is removed. A light is plunged into the residual gas: it is extinguished; the volume of the water which has entered and the capacity of the whole flask are measured, and the former is found to be about ¼ of the latter. These facts clearly demonstrate that the burning hydrogen has combined with the oxygen of the air in the flask.

But where is the product of combustion, the oxide of hydrogen, that must have been formed?

When the burning jet was first placed in the large flask a mist appeared on the inside, and a similar observation was made when hydrogen was burnt from a gas-jar. This must be the hydrogen oxide.

To collect it, it will be necessary to condense it on a cold surface.

Experiment XXII.—*To collect and examine the mist formed by burning hydrogen in air.*

Hydrogen, generated in the usual manner, is dried by passing it through a U-tube containing calcium chloride, and then burnt from a jet placed immediately beneath the bulb of a retort kept cold by

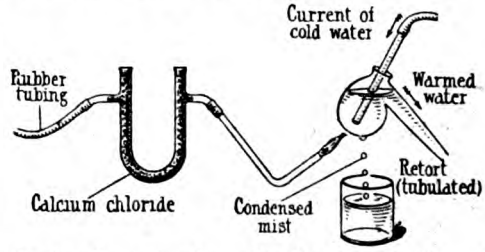


Fig. 9.—Apparatus for collecting the mist formed by burning hydrogen in air.

flowing water. Drops of liquid slowly form at the bottom of the bulb and are collected in a dry vessel placed beneath it.

What is this liquid? It has neither colour nor smell; its taste is decidedly flat, like that of boiled water.

Is the liquid water?

(*a*) A little is evaporated to dryness in an open dish. There is no residue—i.e. it is volatile. Pure water is also volatile, but so are many other colourless liquids.

(*b*) A thermometer is held in the vapour arising from the liquid boiling in a test-tube. The temperature is very nearly 100° C. This is the boiling-point of water.

(*c*) Some of the liquid is put in a test-tube which is immersed in a freezing-mixture of ice and salt. A thermometer indicates that at 0° C. solidification takes place. We conclude that the liquid is probably pure water.

(*d*) Five c.c. are measured into a previously weighed beaker. They weigh very nearly 5 grams. Therefore, 1 c.c. weighs 1 gram. Therefore, the liquid is water.*

Water.—We have already learnt something about the wonderful part which oxygen plays on the stage of life. At the time it might well have appeared the most important substance in the world; but further study leads to the knowledge that there are other substances just as essential. Water is one of these. We do not need to be trained scientists to recognise the utility and necessity of water. The first Greek philosopher, Thales, was so impressed by its omnipresence and seeming omnipotence, that he held it to be the essence of all things, alike their origin and their ultimate end.

Hydrogen oxide presents itself in nature in a variety of forms: ice, snow, hail, hoar frost, water-vapour, steam and liquid water are merely different states of the same chemical individual. The conditions under which these forms are produced and mutually converted belong more to the domain of Physics than to that of Chemistry. The chemist is chiefly concerned with its composition, with the chemical changes it undergoes, and with its very remarkable solvent powers. There is no other liquid which can compare with water in its power of dissolving substances, and not only solid substances but liquid and gaseous also. But for the fact that the chief gaseous constituents of the atmosphere dissolve to some extent in water, marine and fresh-water life as we know it would be impossible.

When fresh water is boiled, or when water is produced in a heated condition as in Experiment XXII., its taste is flat and insipid owing to the absence of dissolved air. All gases without exception dissolve less in a hot liquid than in a cold, in marked contrast with the great majority of solids, of which the solubility increases with rise of temperature. On account of its great solvent action, water found in nature invariably contains more or less dissolved matter.

Even rain water which has been evaporated from the surface of seas, rivers, lakes, etc., by the sun's heat, contains traces of dissolved matter, normally present in the air. When the rain descends upon the earth, about half of it usually evaporates back into the air in the form of water vapour ("fly-off" water). Some of it will drain off ("run-off" water), and the rest will sink into the soil ("cut-off" water. Some of the "cut-off" water will be brought to the surface again by "capillary pull," and be evaporated; some of it will remain adhering to the particles of soil; and, lastly, some of it will percolate downwards until it meets rock of an impervious nature. There it will collect and, when the pressure upon it is sufficient, will come up in the form of a spring. In its passage over and through soil and rock, the water dissolves solid matter, the nature and amount of which will vary with the nature of the soil and strata.

River water contains the same solids that are present in the spring from which it originally came, together with other matter brought in by drainage and tributaries, or dissolved from its own bed. Ultimately these dissolved solids find a permanent resting-place in the sea. The water of the ocean evaporates, but the solids in solution, not being volatile, remain behind. Thus the solid content of sea water must be ever on the increase, although, owing to the huge bulk of the water, this increase is practically imperceptible.* In the case of small seas and inland seas without natural outlet, the accumulation or increase of "salinity" can be detected.

The water of the Dead Sea contains so much dissolved matter that it is very buoyant, and Kinglake, the traveller and historian, relates how, when he bathed in it, he found it almost impossible to swim, his legs and body being lifted so high and dry out of the water. On tardily regaining the shore, he found that his body was thickly encrusted with salts!

Sea water is a perfect museum of curiosities and antiquities where chemist, physicist, zoologist, botanist, geologist and mineralogist may delve and study to their heart's delight. Not only is it frequented by countless hordes of living and dead organisms, but inorganic matter of all kinds is abundantly present in it. Oxygen, nitrogen and carbon dioxide are found in sea water at all depths; sodium, magnesium, calcium and potassium are the chief metals represented, but nearly every elementary substance, including gold, is found in it.

Physical and chemical changes are ever occurring, as the dead and living inhabitants act and react on one another, on the water and on the substances dissolved in the water. Only in one respect is there no change: the composition of the water itself, the hydrogen oxide, is fixed and constant.

Experiment XXIII. — *To find the weight of dissolved solids in* 100 *c.c. of sea water.*

A carefully measured volume, say 10 c.c., of sea water is put into a weighed evaporating basin, and evaporated by gently boiling it on a wire-gauze supported on a tripod stand. When the liquid begins to "spirt," the basin is placed on the top of a beaker half-full of water kept in ebullition by a gas flame underneath. By this means the final evaporation is conducted without loss. It is advisable to dry further the basin and contents by heating them in an oven at 100-110° C. for twenty minutes. The weight is again taken. 100 c.c. of sea water contain on the average 3·5 grams of dissolved solids, of which 2·7 grams consist of common salt.

Similar experiments may then oe performed with tap water, river water, and rain water, but the lower the contents of dissolved solids the greater the quantity of water that must be evaporated.

* The above furnishes a good example of what is known as a *cumulative proof*. No test taken singly is sufficiently cogent to justify the final conclusion; but all the tests—and many more might have been performed—taken together prove that the liquid product of combustion of hydrogen in air is water. Therefore, water (and also steam and ice) is oxide of hydrogen.

* The amount of solid matter carried down to the sea has been estimated at 3·7 cubic miles per annum. At this rate it would take 6,340,000 years for the whole solid land to get down into the sea.

The following table gives the weight of solids contained dissolved in 100,000 c.c. of various natural waters:—

Sea Water—		*River Water*—	
Black Sea	1,770 gms.	Thames at London	40-45 gms.
North Atlantic	3,849 ,,		
Dead Sea	17,000 ,,	Rhine	16-32 ,,
Average	3,400 ,,	Jordan	105 ,,

The average for river water is difficult to determine owing to great variation.

Mineral Waters—		*Rain Water*—	
Vichy	503 gms.	Average	3·5 gms.
Eau de Seltz	407 ,,		

Experiment XXIV.—*To determine the volume of dissolved air in* 1 *litre of tap water.*

A flask holding about 1½ litres is completely filled with tap water, and a rubber cork, through which passes a delivery tube, also filled with water, is inserted in its neck. The end of the delivery tube passing through the cork must not project below it; the other end is placed under a beehive shelf in a trough of water, and a small gas-jar or measuring cylinder stands inverted and filled with water upon the shelf.

On applying heat to the flask, liquid water appears on the outside, and small bubbles of air make their way up through the liquid. Finally, when the water boils, the steam carries the air with it through the delivery tube. On reaching the cold water in the trough, the steam condenses with a metallic sound, but the air passes on and is collected in the cylinder. The heating is continued until the volume of air expelled no longer increases. It is then measured and the amount obtainable from 1 litre of water is calculated.

Ordinary tap water is, as a rule, fully saturated, sometimes supersaturated, with air: it contains about 22 c.c. per litre at 10° C. Owing to the fact that oxygen is more soluble than nitrogen, the composition of air expelled from water is different from that of atmospheric air; the proportion of oxygen to nitrogen in dissolved air is about 1 : 2, whereas in the atmosphere it is 1 : 4.

The amount of dissolved oxygen in a drinking water is of great importance from the point of view of hygiene.

Many of the micro-organisms which cause disease cannot live in the presence of oxygen, and the organic matter upon which such organisms feed abstracts dissolved oxygen from the water: hence if a potable water is found to be deficient in that gas, it must be regarded with suspicion.

Danger can, as a rule, be averted if the water is boiled. This process destroys any germs or bacteria that may be present. Often Nature itself provides a remedy. Nitrogenous matter is disintegrated by the action of certain kinds of bacteria, and ammonia is formed, and other products which are not harmful. E. H. T.

[Photo: American Colony.

FLOATING IN THE DEAD SEA.

The water of the Dead Sea contains so much dissolved matter—17 grm. per 100 c.c. as against 3·8 grm. in the N. Atlantic—that it is very buoyant. A man can float with ease on it, his legs and body being lifted high and dry out of the water.

HEAT.—VI

28. The Unit of Heat.—We have hitherto offered no suggestions for the measurement of heat as a definite quantity: we have been entirely concerned with thermometry, or the measurement of temperature, which is merely the degree of heat.

But if, say, 100 grams of water are heated from 0° to 100°, a certain quantity of heat must have been added to it, and some means ought to be found to measure this. The first need is a suitable and practical unit of heat. This we should most naturally find in referring to the rise of temperature produced in some convenient standard substance: hence we define the unit of heat, or calorie, as *that quantity of heat which would raise the temperature of one gram of water by* 1° *C.*

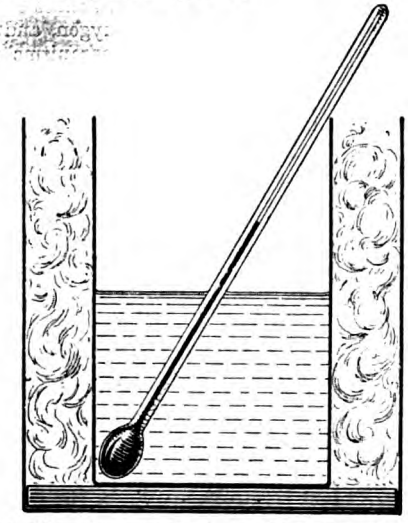


Fig. 40.—Apparatus for making Experimental Measurements of Heat-quantities.

Water is chosen, of course, quite arbitrarily, because, as will appear later, it is the most convenient substance that could be used.

To find the number of calories used in any given case is an easy matter of multiplication. Thus, when 25 grams of water are heated from 20° to 60°, 25 × 40 = 1000 calories are used.

For 1 calorie = amount of heat used when 1 gr. water is heated 1°.

∴ 40 calories = amount of heat used when 1 gr. water is heated 40°.

And 25 × 40 calories = amount of heat used when 25 gr. water are heated 40°.

Our definition tacitly assumes that the amount of heat required to heat 1 gram of water 1° is the same at all temperatures; this is not exactly the case, but it is so nearly true that it may be assumed in all but the most accurate work. For our purposes, we may take the heat required to heat a gram of water from 4° to 5°, or from 20° to 21°, or from 50° to 51°, as 1 calorie in each case.

Moreover, we also suppose that the heat lost when 1 gram of water is cooled 1° is also 1 calorie.

Suppose 50 grams of water at 10° to be mixed with 50 grams of water at 70°: the resulting temperature would be found to be 40°, or very near to it. The heat given out by the hot water in falling from 70° to 40° would be 50 × 30 calories; the heat received by the cold water in rising from 10° to 40° would also be 50 × 30 calories, the heat given out being exactly balanced by the heat received. If we perform the experiment in the manner to be described presently, we shall have ample confirmation of this fact.

Example.—Neglecting outside sources of error, what ought to be the final temperature when 120 gr. water at 10° are mixed with 80 gr. water at 85°?

Let $t°$ = final temperature.

Then 80 gr. water falling $(85 - t)°$ give out $80 \times (85 - t)$ calories,

and 120 gr. water rising $(t - 10)°$ receive $120 \times (t - 10)$ calories.

Equating these two quantities, we have

$$80\ (85 - t) = 120\ (t - 10)$$

or

$$6800 - 80\,t = 120\,t - 1200$$

or

$$200\,t = 8000$$

whence $t = 40°$ C.

The student should invent and work out a few examples on these lines, and test his answers.

In order to make experimental measurements of heat-quantities, we need a suitable *calorimeter*, or heat-measurer. A convenient form is made of thin copper in the form of a cylinder about 4 in. deep and 3 in. in diameter. It should be well polished, and supported in a larger can on a cork support; the space between the two cans should be filled with cotton-wool to prevent still further the escape of heat to the surroundings (Fig. 40). An accurate thermometer is also required, preferably one graduated to fifths of a degree. The weight of the inner cylinder should be obtained, and the water used in the experiments should be weighed and not measured.

When such a calorimeter is used, although the loss of heat to the table and to the surrounding air is reduced to a minimum, some heat must, nevertheless, be expended in warming the calorimeter and thermometer, which rise in temperature as much as the water contained in the former. It is therefore important to discover and allow for this. To do it experimentally we proceed as follows:—

Weigh out in the calorimeter a certain quantity of water, say 40 gr., and take its temperature—12°, suppose. Pour into this a certain quantity of water whose temperature is also known (53° in the given case). Stir smartly with the thermometer, and note the temperature of the mixture when it becomes stationary for a moment (37°). Weigh the calorimeter again, and thus find the weight of water added (68 gr.).

Now, 68 gr. water falling (53−37)°
give out 68 × 16 . . . . = 1088 calories.
And 40 gr. water rising (37−12)°
have received 40 × 25 . . = 1000 calories.

Hence, heat absorbed by the calorimeter + thermometer . . . = 88 calories.

But the calorimeter has been heated also 25°.

Hence, to heat the calorimeter, etc., 1° required 88 ÷ 25 = 3·5 calories.

This number is called the *Water Equivalent of the Calorimeter*, which may thus be defined as the number of calories required to raise the calorimeter one degree.

In the above experiment it is clear that the effect of the calorimeter is the same as would be obtained by adding 3·5 grams of water to that originally in the calorimeter. Hence the suitability of the term "water equivalent." To allow, therefore, for the effect of the calorimeter on our result, we must first find the water-equivalent, and then add it to the weight of water we start with. In this case we should have proceeded as though there were 40 + 3·5, or 43·5, grams of water in the calorimeter at 12°.

29. Specific Heat.—All substances do not fall exactly in line with water in the effect of heat upon them; 1 calorie does not produce in 1 gram of iron, for example, a rise of 1°, but something nearer 10°. Similarly, a loss of 1 calorie would depress the temperature of a gram of iron nearly 10°.

It is a matter of familiar observation that some substances cool more rapidly than others; and this is quite explainable when we realise that different substances have different capacities for heat. Water has a large heat-capacity: hence "the watched pot never boils." The slow heating of water in summer, and its equally slow cooling in winter, are also responsible for the equable climate characteristic of oceanic islands.

In order to make these ideas precise and definite we define *the heat-capacity of a body* as that quantity of heat which is required to raise its temperature 1°. The heat-capacity of unit weight of a body is called the *specific heat* of the substance of which the body is made.

This is an important constant of all substances, and we may express its meaning in a more exact definition as follows:—

The specific heat of a substance is the ratio of the amount of heat required to raise a given weight of the substance 1° *to the amount of heat required to raise the same weight of water* 1°.

Thus, if w grams of a substance whose specific heat is s is heated $t°$, the amount of heat required will be $s\,w\,t$ calories. For it requires s times as much heat to raise w grams of it $t°$ as would be required to raise w grams of water $t°$, i.e. s times $w\,t$ calories.

In order to determine this quantity experimentally we weigh out a known amount of water in a calorimeter, and insert the thermometer in it. Meanwhile a weighed piece of the substance is heated for some minutes in the steam from boiling water, i.e. to 100°, and is then transferred rapidly to the calorimeter. The water is well stirred, and the highest temperature observed is carefully noted.

EXAMPLE.—

Weight of iron cylinder used = 60 gr.

Weight of water (including W. E. of cal.) = 136 gr.

Initial temp. of water = 14°; final temp. = 18°. Rise = 4°.

Initial temp. of iron = 100°; final temp. = 18°. Fall = 82°.

Heat gained by water = 136 × 4 cals. = 544 cals.

Heat lost by iron = $s \times 60 \times 82$ cals. = $4920\,s$ cals.

$$\therefore\ 4920\,s = 544$$

$$\text{and } s = \frac{544}{4920} = 0{\cdot}1105$$

The sources of error in this experiment are important, and can only be overcome by elaboration of the apparatus. The student may, however, reduce them very greatly by skilful handling. A certain amount of heat is lost in transferring the heated body to the calorimeter, and a drop of water may also adhere to it. Further, the rise of temperature is usually small, and a small error in reading this makes a big difference to the result. Lastly, the boiling-point of the water may not be accurately 100°. By paying careful attention to these points a very fair result can be obtained.

The specific heat of a liquid may easily be obtained when that of some solid is known. We have only to substitute the liquid for water in the calorimeter in our previous experiment.

EXAMPLE.—

Weight of copper cylinder = 55 gr.; sp. heat = 0·095.

Weight of turpentine = 119 gr.; sp. heat = s.

Initial temp. of turpentine = 11·5°; final temp. = 19°. . . . . Rise = 7·5°.

Initial temp. of copper = 100°; final temp. = 19°. . . . . Fall = 81°.

Heat given out by copper = 0·095 × 55 × 81 cals.

Heat given out by turpentine = s × 119 × 7·5 cals.

$$\therefore\ s = \frac{0{\cdot}095 \times 55 \times 81}{119 \times 7{\cdot}5} = 0{\cdot}474$$

The specific heat of a liquid may be obtained also by using the law of cooling. Suppose a calorimeter to contain 50 gr. of water at 60°, and that it takes 35 minutes for it to cool down to 50°. Let the calorimeter be now filled with mercury up to the same level as before, and at the same temperature; the amount of mercury will be found to be 680 gr., and it will take, say, 16 minutes to cool from 60° to 50°.

Now, in 35 minutes the water loses 50 × 10 cals. $= \frac{500}{35}$ cals. per minute; and in 16 minutes the mercury loses $s \times 680 \times 10$ cals. $= \frac{6800\,s}{16}$ cals. per minute.

But the rate of cooling depends on two factors which are the same in these two cases: (1) the surface of the vessel; (2) the difference in temperature between the vessel and the surrounding air.

$$\therefore \frac{6800\ s}{16} = \frac{500}{35} \text{ or } s = \frac{500 \times 16}{35 \times 6800} = \frac{4}{119} = \frac{1}{30} \text{ nearly.}$$

30. Latent Heat of Fusion of Ice.—If equal weights of water at 0° and 100° are mixed, the resulting temperature will be, as we have seen, approximately 50°. But if, instead of water at 0°, we had used ice at 0°, the temperature of the mixture would be somewhere near 10°. This large difference is evidence that a considerable quantity of heat is required merely to melt the ice.

The number of calories required to melt one gram of any solid is called the Latent Heat of Fusion of the solid. In the process of melting no rise of

temperature occurs. A thermometer placed in melting ice remains steadily at zero till all the ice is melted.

The reason for the term *latent*, or hidden, is thus evident; though, of course, the heat is not hidden in reality: the mere fact that a substance is liquid implies that it has more heat than it had when it was solid.

To obtain the value of the latent heat of fusion of ice, we again fall back upon the calorimeter. Weigh out about 250 grams of water, and warm it to about 20°–25°. Take the temperature carefully, and then drop in a few pieces of ice, dried from adherent water with flannel, until the temperature falls to about 4°–5°. Stir up well, and read the lowest temperature obtained when all the ice is melted. Weigh the calorimeter, in order to find the weight of ice added. The calculation will then proceed as in the accompanying example:

Weight of water = 250 gr. at 24°.
Temperature reduced to 5° by 56 gr. of ice.
250 gr. of water falling (24 − 5)° give out 250 × 19 = 4750 cals.
56 gr. of water rising 5° receive 56 × 5 = 280 cal.
Hence 56 gr. ice, in melting, require 4750 − 280 = 4470 cals.
∴ 1 gr. ice, in melting, requires 4470 ÷ 56 = 79·8 cals.

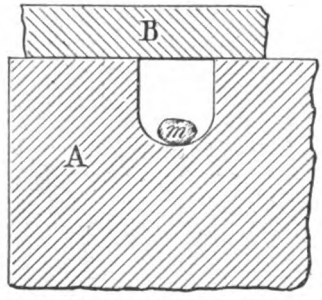


Fig. 41.—The Simplest Form of Ice Calorimeter.

The correct number is 79·2 calories. It follows from this rather large number that the heat required to melt a piece of ice would be sufficient to raise the water formed from it up to 79·2°.

31. Ice Calorimeters.—The latent heat of fusion of ice may be used in the construction of ice calorimeters for the measurement of specific heat. The simplest form of ice calorimeter is that first used by Black in his pioneer researches on latent heat. It consists (Fig. 41) of a block of ice, A, in which a hole is bored, and this hole may be covered with another piece of ice which effectually shuts off heat from outside. The heated metal is conveyed rapidly into the hole, and a certain amount of water is thus formed, which is sucked up into a pipette, or soaked up in a weighed piece of cotton-wool, and weighed.

EXAMPLE.—

Weight of copper ball = 70 gr.
Original temp. = 100°.
Weight of ice melted = 7·7 gr.
Amount of heat given out by copper falling from 100° to 0° = $s \times 70 \times 100$ calories.

Amount of heat required to melt 7·7 gr. ice = $7{\cdot}7 \times 79{\cdot}2$ calories.

$$\therefore 7000\ s = 7{\cdot}7 \times 79{\cdot}2$$

$$\therefore s = \frac{7{\cdot}7 \times 79{\cdot}2}{7000} = 0{\cdot}087.$$

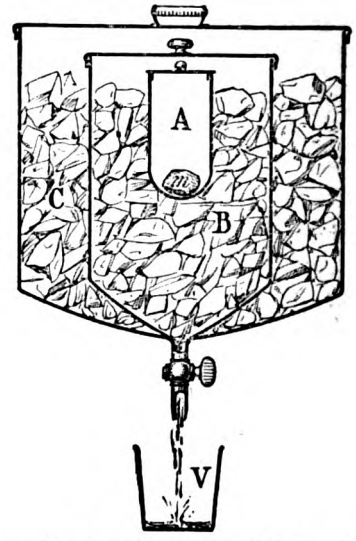


Fig. 42.—Lavoisier's Ice Calorimeter.

The result obtained in this experiment will certainly be too low, because it is impossible to get all the water away from the ice in a satisfactory manner. The difficulty is diminished, but not overcome, in the more elaborate ice calorimeter of Lavoisier and Laplace, represented in Fig. 42.

This consists of three concentric copper cylinders, A, B, C: the outer one contains ice, and does not communicate with the inner ones at all; the middle one, B, also contains ice, but opens into a tube at the bottom, so that any melted ice may be run off into a weighed vessel, V, below; the inner one is a small test-tube of thin copper, and receives the substance to be experimented on. Each of the vessels has a separate lid, put on while the experiment lasts. If a weighed piece of hot metal, *m*, is placed in A, some of the ice in B is melted and runs off into V.

The jacket of ice kept in C prevents any of the ice in B from being melted by heat from outside the calorimeter. Hence the water collected in V has been formed from ice by heat given off by *m*.

The calculation of the required result will proceed as before, and the result will again be low, owing to the difficulty of draining all the water away from B; some of it continues to adhere to the ice very tenaciously.

This difficulty, however, has been surmounted to a great extent by the invention of the Bunsen calorimeter. The main object of this apparatus is to determine the diminution of volume of the ice. It is extremely difficult to carry out, great skill and dexterity being required. Discrepancies occur with the most expert scientists. And ice-calorimetry, in spite of the fact that it can dispense with the use of the thermometer, is still very difficult in its practical application. E. W. E.

ZOOLOGY.—VII

Two of the most terrible facts of life seemed to Darwin that ichneumon flies should feed within the bodies of living caterpillars, and that cats should play with mice! The whole scheme of animal creation, he confessed, was too profound for his understanding. "A dog might as well speculate on the mind of Newton." We, insignificant disciples of that modest giant, experience an overwhelming sense of mystery and discomfiture as we survey the immense order of bloodthirsty animals to which our study now brings us, the Carnivora.

With these Nature is indeed "red in tooth and claw." The order, with its immense assemblage of animals, ranges the entire habitable world, excepting only Australia, New Guinea, and New Zealand. Wherever carnivorous animals live, other animals must die to support them. True, not all carnivora are exclusively addicted to a diet of flesh; bears have as wide a range of diet as man, pigs and rats. But flesh food is, if not the sole, at any rate a paramount element in the sustenance of them all, and the most formidable of the entire order, the cats, rely entirely upon their "kills."

The Carnivora

The carnivora are the warriors, the scourge of the wilds, the slaughterers and devourers. They are the highest yet to which Nature has brought her animate engines of destruction. Nowhere do we find greater perfection of terrible beauty, strength, speed, endurance, intelligence, than in this order; nowhere greater ferocity, more pitiless power, more unbridled lust of slaughter. Day and night, from the arctic zone to the temperate and the torrid, year in and year out, century after century, epoch after epoch, the inevitable war continues, the carnivora against the vegetable feeders, against the flocks of man, against man himself. There is no day but citizens of the British Empire fall victims to the teeth and claws of the great cats; there is no day but cattle, horses and sheep are killed and eaten by them.

The wars of men come, go, recur, and pass again, but the war of the carnivora can never cease until carnivores perish. There is small likelihood of that happening, for in this order we deal not only with upwards of forty species of cats, ranging from lion to lynx; with more than twenty genera of civets, including the mongooses; with hyenas, all the great dog tribe, including wolves and jackals; with bears and raccoons; all the weasel family, embracing the martens, gluttons, skunks, badgers, otters, and what not; but in addition all the seals, the walruses and sea elephants. These are all true carnivora, flesh-eaters, of land and sea.

Sea Lions and Bears

It might seem, perhaps, that, as we take in sea lions and sea bears, we might include another ocean mammal, the grampus But the grampus, although a voracious warm-blooded animal, producing living young and nurturing them as a seal nurtures its offspring, is a purely aquatic animal. The seals and the rest are land animals which pass the greater part of their time in the water. They go ashore to give birth to their offspring, and they have organs of locomotion which, while greatly modified to meet sea conditions, yet remain true limbs for progress on dry land. The grampus, though, like the whale, it must breathe air like ourselves, is a prisoner of the deeps, and perishes, crushed by its own weight, if it be stranded on the shore.

All flesh is as grass to the carnivora. Stock-breeders know to a nicety how much of grass, hay, roots, grain, and other fodder is required to raise a prime bullock, and how long a period must elapse over the conversion of food into beef, so they can tell us what the meal of a lion or tiger costs when the brute is at liberty to pick its victims. Certainly two such animals, possibly three or even four, are weekly required to keep one of these supreme cats supplied. A great animal which has taken two or three years in the building, goes down at the grip of the lion's jaws to make a meal to-day.

Cat and Dog Tribes

Under a hot sky the flesh becomes putrid carrion in the course of very few hours, but the victor will return on the morrow, or even the next day, to finish his repast —if hyenas and vultures have not anticipated him—no matter how utterly repulsive to human senses the banquet may appear. Where cattle, domestic or wild, do not avail, then deer, wild pigs, and lesser herbivores must serve, and every night something must die to make a supper for the meal of lion, tiger, leopard, jaguar, puma. No less voracious are the dog tribe, the weasels and their kin.

Throughout the order there runs what

seems an unreasoning passion for slaughter. Lion or tiger will strike down animal after animal at the end of a successful stalk; weasels and martens will slay indiscriminately; wolves will butcher sheep without stint, foxes kill right and left far in excess of immediate needs. Perhaps here is the dawning of an instinct of providence, an impulse to lay up for the morrow. The great cats devour carrion, as we see; the Arctic fox, with cold storage ready at hand, kills and hoards in time of plenty animals which it eats in time of scarcity.

Carrion Food

A dog hides a bone and returns to find it, and the curious thing is that the more highly bred such an animal may be, the more carefully it is fed on dainties and lapped in luxury, the more will it delight, in moments of stolen freedom, in the horrors of foul food. The pet of the boudoir retains its primeval instinct for carrion, for mouldy, noisome bones. Thousands of years have not bred out of dogs the old jackal strain for unconsidered trifles, pestilent and loathsome.

The carnivore is an executioner, but he is also a scavenger. The more a cat is petted and accustomed to high living, the more certainly will it hunt and kill birds. The necessitous street cat hunts and kills to fill an aching void, but the cat of the luxurious home hunts for sport. Of the hundreds of birds that it kills, not one will it attempt to eat, unless the sufferer happen to be a naked nestling. The mere song of a bird is a challenge to a cat. One recalls a striking evidence of this.

A certain cat, which was the uncrowned king of the house which it graced, was familiar with much music emitted by a gramophone, and was utterly indifferent whether the sounds produced resulted from the human voice or from instruments. But one day a rare record, reproducing the notes of a nightingale, was tried. The cat sat up with a quiver on the hearthrug, watched for a moment, sank low on all fours, and crept, bristling, across the room, reconnoitred the gramophone for a moment, then leapt bodily into the machine! The miracle of the bird's notes which set human nerves tingling with delight was to the cat simply a call to slay, though at the moment the animal was fed to repletion with its twin delights, dainty fish and asparagus.

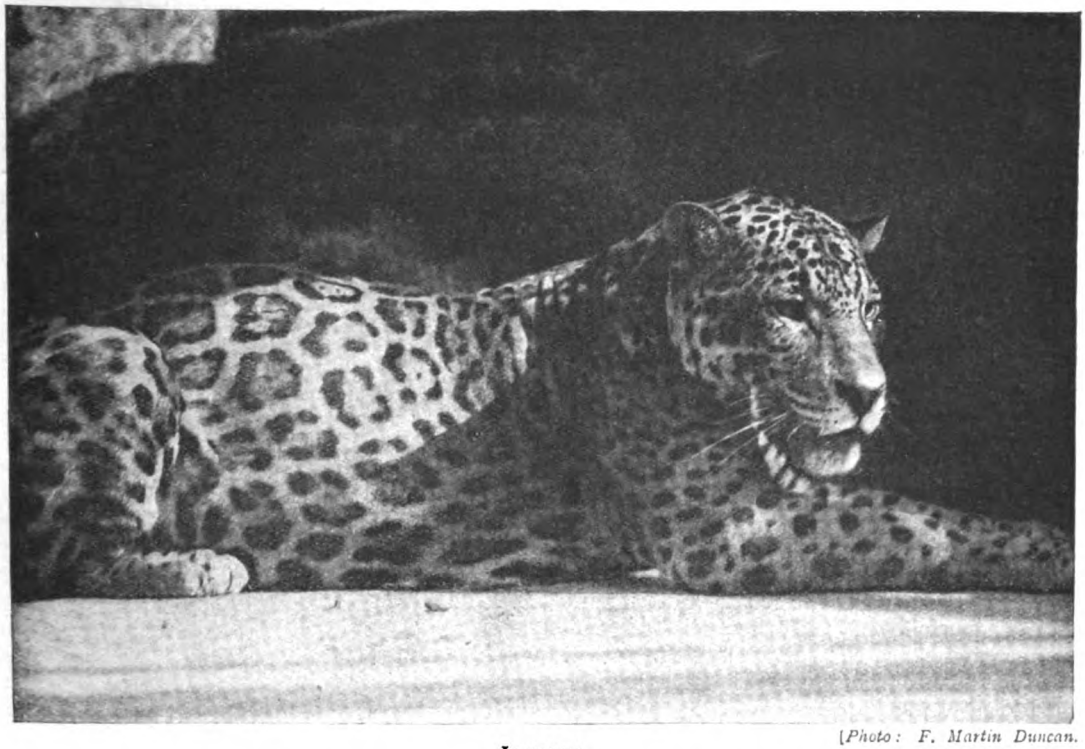
There in essence we get the key of the carnivores' creed. The entire group has been perfected by Nature to the end that its members shall *kill!* Those which kill most swiftly, most surely, most freely, are the foremost of their kind. The best killers have thriven most and left descendants, while the less adroit and ardent strains have perished. With the carnivore the race is to the swift, the battle to the strong, and the whole story is one of rending and riving, the smashing of bone, the ripping of flesh, with blood lust the abiding prime impulse.

The qualities which make the carnivora appear so terrible are older than the carnivora themselves; they were inherited from the carnivorous reptiles whence flesh-eating mammals arose. There is no pity in Nature; a bird, an animal, a species, a genus, a family, is free to adopt whatsoever course of life it will, and Nature imposes no penalty, so long as the animal is able to maintain itself, so long as it and its successors do not isolate themselves from the main stream of life by over-specialisation.

We see what happens from a phenomenon of our own day. The kea, a New Zealand parrot, has taken to devouring the fat surrounding the kidneys of live sheep. There were no sheep in New Zealand a century ago; there were no sheep-killing keas a few years ago. But the birds which have changed their habits thrive immensely on their new diet, and if left unchecked would increase as they never have before. In time all keas would be sheep-killers, and it might finally be as impossible, in conceivable circumstances, to rear sheep in New Zealand, as it is impossible to rear semi-wild horses, owing to a certain fly, in parts of South America. Then the food supply would fail. The specialisation which had made the bird prosperous above its contemporaries would be its undoing. With the decline of food supply upon which it had come entirely to rely, the whole species would die out.

Nature's Penalties

Nature lets her children practise what they will at the expense of their neighbours, and in the carnivora this is notably exemplified. But the records of the past reveal to us that she has demanded full forfeit from species and genera which have gambled, so to speak, upon over-development of special features. The great cave lion and the monstrous sabre-toothed tiger seemed fitted above all others to make their way in life, but something happened which made their strength and



[*Photo: F. Martin Duncan.*

JAGUAR,

the greatest of the carnivorous cats, requires, in his natural state, a meat ration of two prime bullocks weekly.

[*Photo: F. Martin Duncan.*

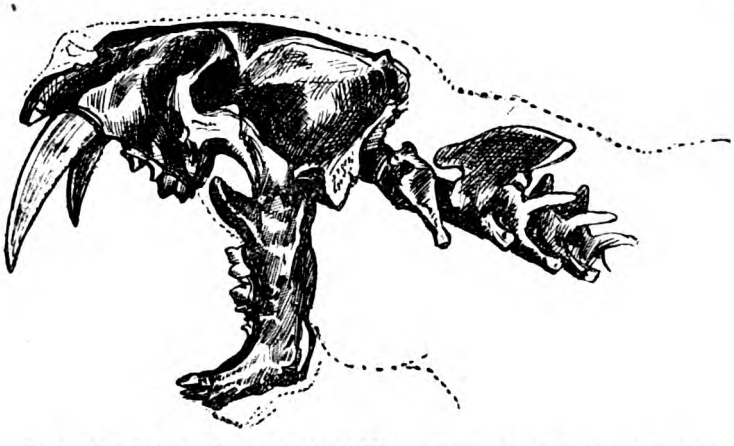
LEOPARD,

a denizen of Africa and Asia, is one of the smallest but fiercest members of the cat tribe.

equipment inimical to life in gradually changing conditions, and to-day both these terrible animals are blotted from the book of life.

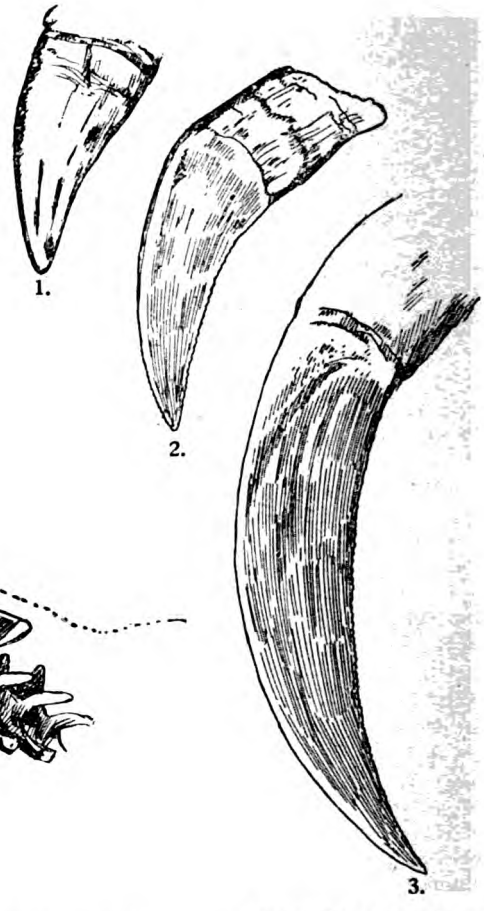
We can trace over a dozen extinct species of great cats, four extinct species of civets or civet-like animals, as many species of hyena, upwards of half a dozen extinct species of the dog tribe, at least three extinct bears, and numerous other primitive carnivora. In some cases one species has slowly given rise to another or more, but in others there has been as clear an extinction as in the case of the sabre-toothed tiger.

We shall never know why these old-time terrors of the twilight world went out, but it is safe to assume that, generally speaking, they became in time less qualified to meet the changing hazards of battle and pursuit than their fellows, and that the present-day carnivora are the survival of the fittest. Terrible as are the physical powers of the modern lion or tiger, they seem relatively insignificant when contrasted with those which are implied by the structure of the sabre-tooth. The gape of a lion suffices now to enclose a man's head, but the gape of the tiger must have been still more prodigious to enable the monster to bring its special equipment, the frightful saw-edged canine tusks, into operation.



Gape of a British Sabre-toothed Tiger, drawn from a Skull in the Museum of the College of Surgeons.

We must assume that the modern carnivora have survived and progressed by sacrificing something of armament to development of brain. For there is high development of brain matter among the carnivores; brains convoluted and grooved in such a manner as to suggest the extremely active intelligence which we all know to be exhibited by many members of the order. That great skill and ability may be associated with a more primitive brain will be seen in subsequent lessons, but here we must note that enlargement and improvement of brains is a pronounced feature of this prosperous indomitable order.



UPPER CANINE TEETH OF CARNIVORA.

1. *Felis Leo* — Ordinary lion. 2. *Machairodus Latidens* — Sabre-tooth tiger. 3. *Machairodus Cultridens* —The great tiger of the Pliocene age.

The life of the carnivore demands this aid. With the cat tribe life would be an impossibility without the exercise of great cunning. Skill, and the art of introducing the element of surprise into hunting operations, are indispensable, for though wolves and dogs and jackals are tireless, the cats expend the greater part of their running powers in enormous explosions of force.

A crouch, a creeping forward, then a short gallop and a frightful blow home, and the struggle is ended. No member of the cat tribe makes a long pursuit. No deer or antelope was ever run down in a straight race of any duration by lion, tiger, or leopard. But the stealthy stalk, then the sudden, overpowering rush, with a bone-smashing crunch of the mighty jaws at the back of the neck, followed by a deep, throttling bite in the throat—those are the tactics which give the lion his supper.

The ungulates have greater speed for distance than the cats, hence we find, as we might expect, that the pursuers which must call artifice to their aid are infinitely better furnished mentally than the pursued. Affectionate appreciation of every sign of intelligence in one's horse or pony may make one reluctant to admit that the latter is less intelligent than his cat or his dog, but wherever a horse has a dog or a cat for stable companion it is always the carnivore which rules, never the larger animal.

Brain and Brawn

It may be unsafe, perhaps, to attempt to make out a case of mental superiority for the cat or dog on these grounds, but the fact will bear pondering. Be it large or small, it is invariably the acute, keen-brained little flesh-eater which governs the stable and its owner—never the horse.

Brain and brawn are a formidable combination, attaining their highest expression for a particular end in the great cats. These in truth are the pinnacle of physical perfection, regarded from the angle of the life which the animals lead. The teeth and claws are, of course, characteristic features of the order. The system of dentition is not uniform with so many genera of animals concerned, but throughout the order the teeth are divided into incisors, canines and cheek teeth. Invariably in the land animals one tooth on each side of the upper jaw is modified to bite against a corresponding tooth on each side of the lower jaw in a manner resembling the action of scissors. Lions, tigers, and their kindred cannot masticate their food. They simply shear and cut it into pieces.

The jaws are so knitted together as to be incapable of rotatory or backwards and forwards motion for grinding. Hyenas and dogs which crack bones reduce them to splinters and their meat to chunks, and bolt both, for their jaws move simply up and down. E. A. B.

ASTRONOMY.—VII

THE history of the invention of the telescope is by no means clear, which is partly due to the fondness of ingenious authors for describing projects which they had formed as if they were performances which had actually been carried out. Thus, for example, the celebrated English philosopher Roger Bacon, writing about the year 1260, gives a pretty clear account of what lenses of glass might be made to do. "And thus," he says, "from an incredible distance we may read the smallest letters, . . . and thus a small army may appear a very great one, and though very far off, a very near one. And thus also the sun, moon, and stars may be made to descend hither in appearance, and to be visible over the heads of our enemies."

But one may suspect from the very words of this passage that Roger Bacon never actually was possessed of a telescope, or he would have found that a small army does not through a telescope appear a very great army, but only a small army composed of larger men. And at any rate, if he did possess a telescope, its actual use remained unknown until very long after his day.

A somewhat similar account of a telescope is found in the writings of Thomas Digges. He proudly declares that his father had "by proportional glasses, duly situated in convenient angles, not only discovered things farre off, read letters, numbered pieces of money, with the very coyne and superscription thereof, cast by some of his freends of purpose upon downes in the open fields, but also seven miles off declared what hath been done in private places."

The Earliest Telescope

Again we may doubt if this is an account of what actually happened, rather than a conception of what might have happened if he had been able to construct the instrument of which he clearly imagined the powers. For not until some forty years later do we find the telescope actually in use.

Early in the seventeenth century three men, all of them Dutchmen, seem to have hit upon the idea of the telescope independently. There has been a good deal of controversy as to their respective degrees of merit in the invention; but at least it is established by documents preserved at Leyden and at The Hague that on October 2nd, 1608, John Lipperhey, a spectacle maker of Middelburg, applied for the right of the exclusive privilege of making an instrument for seeing at a distance, and

that on the 17th of the same month Jacob Andrianzoon petitioned for the same exclusive privilege, declaring that his instrument was as good as that of Lipperhey.

And now comes a curious thing. The Assembly of the States General undertook to pay Lipperhey 900 florins if he would make an instrument that would enable one to look through it with both eyes—which the

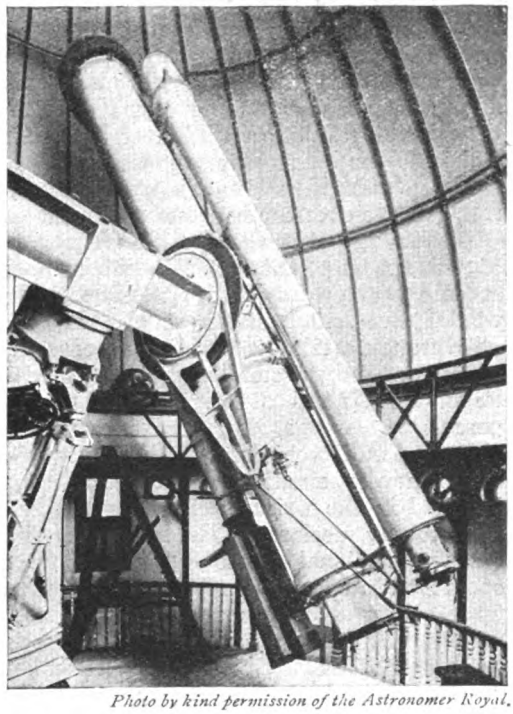


Photo by kind permission of the Astronomer Royal.

The Thompson Equatorial 26-in. Refractor. One of the finest photographic telescopes in the world.

inventor did; so that the binocular telescope is almost as early as the single. Further, they undertook to pay him at the same handsome rate for two more instruments, on condition that he made no others except for them. They did this because they believed that they were acquiring an invention which would be very valuable in warfare, as, indeed, was the case. But it was not possible to keep the invention secret, for, as we have seen, it was already in the hands of others; and within a very short time the new instrument was carried from Holland to England and all over the Continent.

Some time in the course of the following year Galileo of Padua heard of the Dutch invention, and after a little reflection he saw how the effect must be produced, and made a telescope of his own, which magnified three times—about the magnifying power of the small opera glass of the present day, and probably not a bit better than the Dutch telescopes. But he did not rest there. By continual experiment he eventually made telescopes which magnified as much as thirty times, and with these he made the discoveries in the heavens which have immortalised his name—in particular, the discovery of the four moons of Jupiter, and of the stellar composition of the Milky Way.

Now, it is important to realise exactly how it was that while others had the Dutch telescopes, and had the curiosity to turn them to the sky, it was Galileo who made the great revolution in astronomy, and not any of the others. The fact is, that while many had the intelligence to go a little way, so far as to examine the full moon, and to report that "she appeares like a tart that my cooke made me last weeks," as Sir

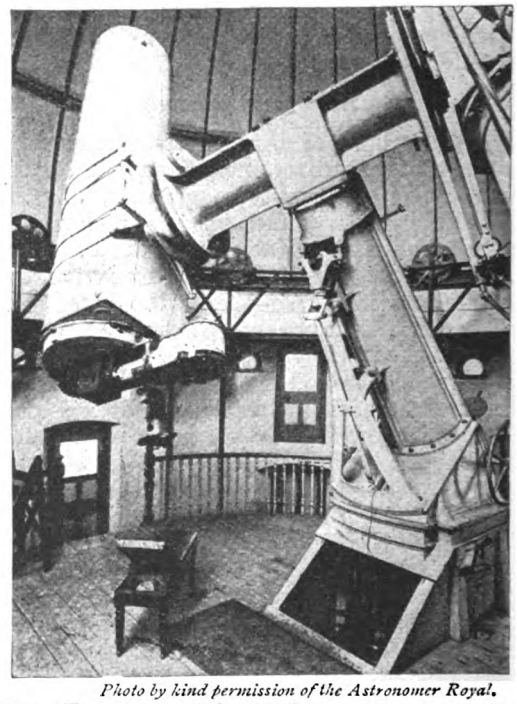


Photo by kind permission of the Astronomer Royal.

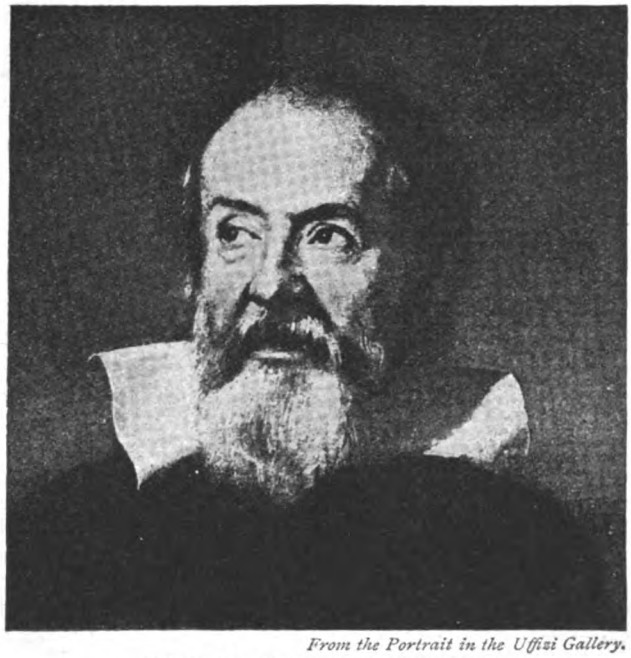
The Thompson 30-in. Reflector on the same Mounting with the 26-in. Refractor.

William Lower wrote from Carmarthenshire, only Galileo had the genius and the patience to go the whole way, and to perceive that his four moons of Jupiter were the verification of the Copernican theory of astronomy.

The talent to push observation farther than will satisfy mere curiosity, to follow it up and put the results together, and make a real advance in knowledge, is apparently

the rarest of all the talents; much rarer than the power to construct theories upon the results of other people's observations.

Galileo himself showed some limitations in this respect. He had made several famous discoveries, but he missed a great many others which were well within his reach, for he never found the Orion nebula nor the splendid great cluster of stars in the constellation Hercules which, although it is actually visible to the unaided eye, was apparently never looked at with the telescope until a century and a half later. In fact, we shall see that not only Galileo but also those who came after him were somewhat deficient in what we may call the courage of discovery; they gradually improved the knowledge of the bodies in the sky which were obviously there, i.e. the planets and the sun and moon, but they did very little in the way of exploring the sky for objects which were not known beforehand to be there to be studied.



From the Portrait in the Uffizi Gallery.

GALILEO OF PADUA (1564-1642),

the Father of Scientific Astronomy. The discovery of the four moons of Jupiter was one of his many notable achievements.

The great difficulty which faced the early workers with the telescope was, of course, the want of any skilled assistance of the optician. Although the optician could make spectacle lenses of a kind, he naturally knew very little about the processes required for making lenses of greater power and an altogether higher precision. Moreover, there was a great difficulty in obtaining glass of the necessary degree of purity and regularity.

Nevertheless, in spite of these obstacles, during the century which followed the first construction of the telescope very considerable progress was made, and telescopes of surprising size were constructed by Huyghens and by Hevelius. On looking at these it strikes one at once that they are extraordinarily long: so long, in fact, that it has been necessary to dispense with the tube and to make the telescope nothing more than a long and light though stiff beam with a big lens at one end, a few diaphragms in the middle, and the eye-piece at the other end.

As the telescope became longer it naturally became more and more unmanageable, and it is extraordinary to think that it was possible to manage at all such unwieldy machines and to point them at the object which it was desired to see. Nevertheless, a few keen and skilful and enterprising men did succeed in making remarkable discoveries with these strange instruments, more especially on the planets; but their use was confined more than ever to the study of objects, such as the planets, whose existence at any rate was already well known.

These cumbrous machines were utterly unadapted for exploring, and we find that they did, in fact, very soon reach a limit of size which was quite unmanageable. It is natural to ask why they were made so long. The answer, though simple, is not easy to explain without some greater knowledge of the theory of the telescope than we have acquired at the moment. To put it briefly, the telescopes were made longer and longer in the attempt to avoid an almost unavoidable defect in the performance of a single lens; and it was not for nearly a century that a more practicable way of doing this was discovered.

Meanwhile, attempts had been made to see whether it was not possible to avoid the apparently insuperable defects of the lens by using a mirror instead. Among those who devoted themselves to the problem was the illustrious Newton, who was the first man actually to construct a telescope in which the image was formed by a mirror instead of by a lens. The little telescope,

less than a foot long, which he made and exhibited to the Royal Society in 1671, is still preserved in the Library of the Society.

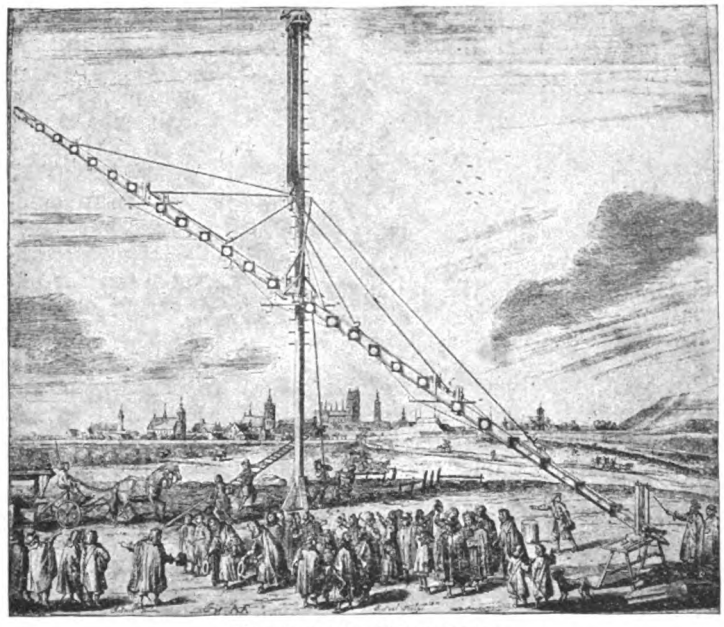
But it must be confessed that Newton was probably more interested in the construction of this instrument than in putting it to astronomical work, and it does not seem to be on record that he made celestial observations of any importance with it. It was not until some thirty or forty years after he had shown the instrument at the Royal Society that reflecting telescopes were increased much in size or in workmanship and became articles of ordinary commercial manufacture.

Nor, when they did—when, for example, the optician Hearne began to make telescopes such as the one which is preserved in the Library of Trinity College, Cambridge, and was for a long time falsely labelled "Newton's Telescope"—was any considerable progress made in the explorations of the sky.

Gradually the telescope had been applied to measurement, in making catalogues of stars, and in the discovery of those all-important quantities in astronomy—the distance of the sun, and the various movements of the poles, and the amount by which the stars are displaced owing to the movement of the earth from which they are observed.

But our point is that until the time when William Herschel came upon the scene, comparatively little had been done in exploring the sky for new things and in pressing forward to more profound depths of space. Astronomers had been content with the sun and the moon and the planets, and with using the stars as fixed points in the sky. They had concerned themselves singularly little with the idea that there might be depths of the universe and denizens of the universe to be discovered by the bold explorer.

NEWTON'S TELESCOPE.



HEVELIUS'S TELESCOPE.
One of the most remarkable of Eighteenth Century Monster Telescopes. (*See p.* 413.)

The revolution in telescope construction which we owe to Herschel is so important that we will devote some little space to the story of his life and works. Within the last few years William Herschel's papers have been republished at the joint expense of the Royal Society and the Royal Astronomical Society. Now, it is not uncommon to erect as a memorial to a distinguished man of science a handsome edition of the papers in which he has made known, step by step, his discoveries to the world. But it is an exceedingly uncommon occurrence to find that a hundred years after a man's death his papers have more than an historic interest and are still full of wise counsel and understanding.

A. R. H.

Continued from page 361.

LANGUAGES:

***Contributors*:—LATIN, GREEK and FRENCH (E. A. Baker, M.A., D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).**

LATIN.—VII

Relative Pronouns

THE Relative Pronouns consist of **quī**, **quae**, **quŏd**, *who, which, that*, and two indefinite relatives formed from this, viz.

quīcumquĕ, quaecumquĕ, quodcumquĕ, *whoever, whatever*
quisquīs, quidquĭd (*or* **quicquĭd**), *whoever, whatever.*

The former is usually employed as an adjective, but is sometimes a substantive; the latter is nearly always a substantive. **Qui** is declined thus :—

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	qu-**ī**	qu-**ae**	qu-**ŏd.**
Acc.	qu-**em**	qu-**am**	qu-**ŏd.**
Gen.		cū-**iŭs**	
Dat.		c-**ui** (Eng. pronunciation kī, as in *kind*).	
Abl.	qu-**ō** (*or* qu-**ī**)	qu-**ā** (*or* qu-**ī**)	qu-**ō** (*or* qu-**ī**).
		Plur.	
Nom.	qu-**ī**	qu-**ae**	qu-**ae.**
Acc.	qu-**ōs**	qu-**ās**	qu-**ae.**
Gen.	qu-**ōrum**	qu-**ārum**	qu-**ōrum.**
Dat.		qu-**ībŭs** (or in poetry qu-**īs**).	
Abl.		qu-**ībŭs** (or in poetry qu-**īs**).	

The first part of **quīcumquĕ**, etc., is similarly declined, the ending **-cumquĕ** (sometimes spelt **-cunquĕ**) being indeclinable. Besides the nom. masc. sing. **quisquis**, the only forms in use of the other compound are the neut. sing. **quidquĭd** (or **quicquĭd**) and the abl. sing. **quōquō.**

Interrogative Pronouns

The Interrogative Pronoun **quīs**, **quae**, **quĭd**, *who? which? what?* may be used either as a substantive or as an adjective, except **quĭd**, which is substantive only, and the nom. sing. masc. form **quī** and the neut. **quŏd**, which are adjectival only. The declension is as follows :—

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	qu-**ĭs** (or qu-**ī**)	qu-**ae**	qu-**ĭd** (or qu **ŏd**).
Acc.	qu-**em**	qu-**am**	qu **ĭd** (or qu **ŏd**).
Gen.		cū-**iŭs**	
Dat.		cu-**i**	
Abl.	qu-**ō** (or qu-**ī**)	qu-**ā** (or qu-**ī**)	qu-**ŏ** (or qu **ī**).
		Plur.	
Nom.	qu-**ī**	qu-**ae**	qu-**ae.**
Acc.	qu-**ōs**	qu-**ās**	qu-**ae.**
Gen.	qu-**ōrum**	qu-**ārum**	qu-**ōrum.**
Dat.		qu-**ībŭs** (or in poetry qu-**īs**).	
Abl.		qu-**ībŭs** (or in poetry qu-**īs**).	

The abl. sing. **quī** is used only in the sense *how? wherefore?* The addition of the particle **-nam** gives force to an interrogation, thus **quisnam** (or **quīnam**), **quaenam**, **quidnam** (or **quodnam**), *who, which, what, pray?*

When the question asked bears the signification *which of two*, the adjective **ŭtĕr**, **ŭtra**, **ŭtrum** is used.

Indefinite Pronouns

The Indefinite Pronouns **quis**, **qua**, **quid**, *any, any one, a*, are declined as follows :—

		Sing.	
	Masc.	*Fem.*	*Neut.*
Nom.	qu-**ĭs** (or qu-**ī**)	qu-**ă** (or qu-**ae**)	qu-**ĭd** (or qu-**ŏd**).
Acc.	qu-**em**	qu-**am**	qu-**ĭd** (or qu-**ŏd**).
Gen.		cū-**iŭs**	
Dat.		cu-**i**	
Abl.	qu-**ō** (or qu-**ī**)	qu-**ā** (or qu-**ī**)	qu-**ō** (or qu-**ī**).
		Plur.	
Nom.	qu-**ī**	qu-**ae**	qu-**a** (or qu-**ae**).
Acc.	qu-**ōs**	qu-**ās**	qu-**ae** (or (qu-**ae**).
Gen.	qu-**ōrum**	qu-**ārum**	qu-**ōrum.**
Dat.		qu-**ībŭs** (or in poetry qu-**īs**).	
Abl.		qu-**ībŭs** (or in poetry qu-**īs**).	

As a rule, this indefinite pronoun is used only after **nĕ**, *lest*, the interrogative particle **num**, **sī,** *if*, or **nisī**, *unless*, **nĕ quīs** may be combined, thus **nĕquīs**, *lest any one;* and in the same way **num quīs** may become **numquĭs**, *any one?* and **sī quīs**, **sīquĭs**, *if any one.* As in the interrogative, the nom. sing. forms **quī** and **quŏd** (acc. sing. also in neut.) are used adjectivally only.

Compound Indefinite Pronouns

The distinctive meanings of the following compound indefinite pronouns should be learned with care. They are used both as substantives and adjectives, with similar distinctions of substantival and adjectival forms as in **quīs**, **quă**, **quŏd**. The prefixes **ălī-**, **ec-**, and the suffixes **-dam**, **-lĭbĕt**, **-pĭam**, **-quam**, etc., are invariable. The variable portion is declined like **quīs**, **quă**, **quŏd** (with the nom. sing. as given below), but there is no ablative form **quī** or **quīs**, and the nom. and acc. plur. neut. are identical with the nom. sing. fem. **Quemdam** and **quamdam** often appear as **quendam** and **quandam**.

The compound indefinite pronouns may be grouped as follows, according to their affinities of sense:

1. **quisquĕ**, **quaequĕ**, **quidquĕ** or **quicquĕ**, *each* (used substantively); **quisquĕ**, **quaequĕ**, **quodquĕ**, *each* (used adjectivally); **quīlĭbĕt**, **quaelĭbĕt**, **quidlĭbĕt** (subst.) or **quodlĭbĕt** (adj.), *any you please;* **quīvīs**, **quaevīs**, **quidvīs** (subst.) or **quodvīs** (adj.), *any you will.* **Unŭs quisquĕ**, *each one*, when written as one word **ūnusquisquĕ** is declined in both parts as if written separately. The nom. forms are **ūnusquisquĕ**, **ūnăquaequĕ**, **ūnumquicquĕ** or **ūnumquodquĕ**, and the gen. is **ūnīuscūiusquĕ.**

2. **ălĭquĭs**, no fem. **ălĭquĭd**, *someone* or *something* (used substantively); **ălĭquī**, **ălĭquă**, **ălĭquŏd**, *some* (used adjectivally); **quispĭam**, **quaepĭam**, **quidpĭam** or **quippĭam** (subst.) or **quodpĭam** (adj.) *any one* or *anything*, *someone* or *something;* **quīdam**, **quaedam**, **quiddam** (subst.) or **quoddam** (adj.) *a certain one.*

3. **quisquam**, **quaequam**, **quidquam** or **quicquam**, *any one at all* (adjectival use supplied by **ullŭs**), used when a negative is implied.

4. **ecquĭs**, no fem. **ecquĭd**, *any one?* (used substantively); **ecquī**, **ecquae** or **ecquă**, **ecquŏd**, *any?* (used adjectivally).

Ecquĭs (or **en-quĭs**) is used interrogatively in the same way as **numquĭs**, which is similarly declined.

Finally, among the pronouns may be classed the pronominal adjectives (interrogative and relative) **quālĭs**, *of what kind?* or *as*, **quantŭs**, *how great?* or *as great*, and **quŏt**, *how many?* or *as many;* with their correlatives, **tālis**, *such*, **tantŭs**, *so great*, and **tŏt**, *so many.* From these are formed the relatives, **quāliscunquĕ**, *of what kind soever*, **quantuscunquĕ**, *how great soever*, **quotcunquĕ** or **quotquŏt**, *how many soever*, **quŏt** and **tŏt** are indeclinable; the other forms are regularly declined, the suffix **-cunque** being, of course, invariable.

The preposition **cum**, *with*, usually follows instead of preceding the relative pronoun, as in **quĭbuscum**, **quōcum**, *with whom* or *with which.*

THE VERB

In all languages the most important class of words are the verbs, those words without which the sentence cannot exist, and in inflected languages, like Latin, Greek, or French, the learning of them presents a severe task, which, however, must needs be undertaken at an early stage. In Latin the inflexions of the verb express the differences of voice, mood, tense, person, and number—differences that in English are usually expressed by means of auxiliary verbs. The regular verbs are classed under four conjugations, each of which has its own characteristics, and there is a large number of irregular verbs outside these which must be learned separately.

Verbs may belong either to the Active or the Passive Voice, i.e. they may express action performed or sustained by the subject of the sentence. Thus, **ămō,** *I love*, is in the active voice, **ămŏr,** *I am loved*, in the passive. Active verbs may be either transitive or intransitive. Transitive verbs are those of which the action affects an object, normally represented by a substantive in the accusative case. Intransitive verbs are those whose action does not affect any person or thing. A deponent verb is one having the form of the passive but an active meaning. These last may be transitive, intransitive, or reflexive, thus **vĕrĕŏr pĕrīcŭlum**, *I fear danger;* **văgŏr**, *I ramble* or *wander;* **pascŏr**, *I feed* or *support myself* (with food).

The Latin verb has three moods, the Indicative, Subjunctive and Imperative. The Indicative, which corresponds to the same mood in English, asserts or states something positively and unconditionally. The Subjunctive has several uses, for instance, (a) subordinate to another verb, it

may express purpose, consequence, or contingency, thus:

vēnī ut audĭam,	*I have come in order to hear.*
sīc ĕum dīlīgēbăt ŭt pătĕr ēiŭs hăbĕrētŭr,	*He loved him so much that he was regarded as his father.*
sī nĕgem, mentiăr	*If I denied it, I should tell a lie.*

The subjunctive, not subordinate to another verb, may be used imperatively, i.e. to express a command or desire, as **vīvāmŭs**, *let us live*, **vīvăt Cæsar**, *Long live Cæsar!* or **lĕgăt ălīquīs**, *Let someone read.* The multifarious uses of the subjunctive will be dealt with more fully under syntax.

The Imperative commands, as **ămā mātrem tŭam**, *love thy mother.*

The so-called Infinitive Mood is really a verbal noun.

There are six tenses of the finite verb, expressing the time of the action or whether this is regarded as continuous or complete:

(1) Present, **ămō**, *I love* or *I am loving.*
(2) Imperfect, **ămābam**, *I was loving.*
(3) Future, **ămābō**, *I shall love.*
(4) Perfect, **ămāvī**, *I loved* or *I have loved.*
(5) Pluperfect, **ămāvĕram**, *I had loved.*
(6) Future-perfect, **ămāvĕrō**, *I shall have loved.*

The last three tenses in the passive voice are formed, just as in English, by the passive participle with the verb **sum**, *I am*, thus: perfect, **ămātŭs est**, *he was loved*, **ămātŭs ĕrăt**, *he had been loved*, **ămātŭs ĕrĭt**, *he will have been loved.* The participle is, of course, declinable, thus **fīlĭă mĕă ămātă est**, *my daughter was loved*, **fīlĭī ămātī sunt**, *the sons were loved*, **fīlĭae mĕae ămātae sunt**, *my daughters were loved.*

The subjunctive mood has four tenses, present, imperfect, perfect and pluperfect; the infinitive three, present, perfect and future. These will be imprinted on the memory best by continual reference to the tables of conjugations that follow.

Difference in person is indicated by difference in the termination, as in English to a certain extent, thus: **ămō**, *I love*, **ămās**, *thou lovest*, **ămăt**, *he loves.*

In Latin it is not usual to insert the subject of the verb except in the third person, and often not even here, since **ĕgŏ** *I*, and **tū**, *thou*, are implied in the form of the verb, **ămō** and **ămās**, and need only be inserted for the sake of emphasis. It depends upon the context whether the subject should be inserted in the case of the third person, thus we may have **pătĕr ămăt**, *the father loves*, or simply **ămăt**, *he* or *she loves.*

In Latin there are two numbers, singular and plural, which are also expressed by inflexions, thus: **ămāmŭs**, *we love*, **ămātĭs**, *you love*, **ămant**, *they love.*

It must be carefully noted that the plural is not used for the second person singular, as is the common usage in English. Thus **ămās**, *thou lovest*, would usually be translated *you love;* but if we intend *you love* to imply several persons in the subject we should use the plural form **ămātĭs.** On the other hand, Latin sometimes employs the plural for the singular in the first person, as in the editorial or royal "we" in English.

VOCABULARY

atquĕ, *and.*
auctōrĭtas, -ātis (f.), *authority.*
dēsĭdĕrĭum, -i (m.), *desire, longing.*
dux, dūcis (m.), *leader, general.*
estĭs, *you are.*
fluxus, -a, -um, *fluid, fleeting.*
forma, -ae (f.), *form, beauty.*
frăgĭlĭs, -ĕ, *fragile.*
impŏtens, -ntis, *powerless.*
mĕmor, -ŏris, *mindful.*
mĕmŏrĭa, -ae, *recollection.*
mīrus, -a, -um, *wonderful.*
sors, -tis (f.), *lot, fortune.*
sĭtus, -a, -um, *situated.*
stultus, -a, -um, *foolish.*
vidi, *I have seen.*

Exercise 6

Translate into English:—

1. In Italiam eodem tempore hostes veniunt. 2. Nostra omnis vis in animo et corpore sita est. 3. Egomet hanc rem vidi. 4. Ille vir mihi multa praemia dat. 5. Hic est homo qui domi manet. 6. Ea ipsa causa belli est. 7. Homines ista auctoritate praediti qua vos estis. 8. Divitiarum et formae gloria fluxa et fragilis est. 9. Sibi videtur mirus et sapientissimus vir. 10. Huiusce rei potestas omnis in vobis sita est, judices.

Translate into Latin:—

1. This is the same king that came into Italy. 2. The fool is powerless over (not master *of*) himself. 3. Whose garden is this? It is all mine. 4. This general has very brave soldiers. 5. Wonderful is my longing for the city, my friends, and you. 6. Our friends are not unmindful of us. 7. Death is the common lot of all men. 8. Who is the poet that sings the praises of Italy? 9. These gifts are very pleasing to me. 10. That town of yours is in the hands of the enemy.

Key to Exercise 5

1. Lucretius and Virgil are the best of all the Roman poets. 2. The mountains and the woods are the most beautiful part of the island. 3. The time of life is briefer than that of death. 4. Caesar is the most illustrious of all men. 5. This is the year 1915 after the birth of Christ. 6. There are 334 boys in the school. 7. What hour is it? It is the ninth. 8. Three thousand of the enemy remain in the town. 9. My father is four years older than yours. 10. The pretence of love is worse than hate.

1. Nihil quam virtus amabilius est. 2. Pauperes munificentiores quam divites saepe sunt. 3. Hirun-

dines quam passeres velociores sunt. 4. Omnium hominum beatissimus sapiens est. 5. In adversis rebus multi homines prudentiores sunt quam in secundis. 6. Bono viro pauci inimici. 7. In binis castris hostium octo milia militum sunt. 8. Mihi patris tui quaternae literae sunt. 9. Hic annus est sexcentesimus undecentesimus ante Christum natum. 10. Filia mea sapientior est quam filius.

E. A. B.

FRENCH.—VII

Indefinite Adjectives.—We have already used several of the indefinite adjectives in our illustrations. They show that the word before which they stand is used in a general or indefinite way. They comprise the following :—

aucun, aucune, *any, no ;* autre, *other, another ;* certain, certaine, *a certain, some ;* chaque, *each ;* maint, mainte, *many ;* même, *same ;* nul, nulle, *none, no ;* plusieurs, *several ;* quel, *such, what a ;* quelconque (placed after its substantive), *whatever, whatsoever ;* quelque, *any, some ;* tel, telle, *such ;* tout, toute, *all, every.*

Those not accompanied above by a feminine form are invariable, so far as gender is concerned. Be careful not to mistake the indefinite adjective **certain**, *one, some, a certain*, for the qualifying adjective *certain, sure*. **Aucun** and **nul** are now employed only in a negative sense, and with the accompaniment of **ne** ; thus—

Aucun de nos soldats n'a fait rien de semblable.	*Not one of our soldiers has performed such a deed.*
Nul n'est content de son sort.	*No one is satisfied with his lot.*

Examples :—

Votre ami a quelque chose d'agréable.	*Your friend has something pleasant.*
Le Danois a-t-il quelques pommes ?	*Has the Dane a few apples ?*
Il en a quelques-unes.	*He has a few.*
Il en a plusieurs.	*He has several.*

The Interrogative Adjective is **quel, quelle**, plur. **quels, quelles**, used for *which* or *what* only before a substantive, thus—

Quel habit avez-vous ?	*Which* or *what coat have you ?*
Quelle serviette avez-vous ?	*Which* or *what napkin have you ?*
Quelles bourses votre ami a-t-il ?	*What purses has your friend ?*

Pronouns.—The adjectives which we have been considering, especially the demonstrative, possessive, and indefinite or interrogative adjectives, are closely allied to the pronouns, as the reader will now see. Thus **ce, celui, celle**, *this, that, it*, are obviously connected with **ce, cette**, *this ;* the possessives **mon**, *my*, **ton**, *thy*, **son**, *his* or *her*, with **me**, *me*, **te**, *thee*, **se**, *himself* or *herself*, and with **le mien**, *mine*, **le tien**, *thine*, **le sien**, *his, hers, its ;* and the same with a number of the relative and indefinite pronouns. The student should collate these relationships for himself ; he will find this very helpful.

There are six kinds of pronoun, just as there were six of adjectives—the principle of classification is the same, and the kinds correspond almost exactly. These are as follows :—(1) Personal, (2) demonstrative, (3) possessive, (4) relative, (5) indefinite, (6) interrogative.

(1) Personal pronouns serve to point out the persons or things spoken of, and by their form show whether they are the subjects or objects of the action, as **il**, *he*, and **vous**, *you*, in—

Il m'a parlé de vous.	*He has spoken to me about you.*

(2) Demonstrative pronouns are used to distinguish the person or thing spoken from any other, as **celui-là** in—

Cet homme-ci est plus riche que celui-là.	*This man is richer than that one.*

(3) Possessive adjectives are used to represent the object possessed, thus—**le mien** or **la mienne**, *mine ;* **le vôtre** or **la vôtre**, *yours.*

(4) Relative pronouns are used in complex sentences to represent in the subordinate clause a noun or pronoun which is the subject or object of the principal sentence. Thus, in the sentence—

Le feu, qui dévore, consume et ne produit pas.	*Fire, which devours, consumes and does not produce.*

the relative **qui**, *which*, represents in the subordinate clause, **qui dévore**, *which devours*, the antecedent **le feu**, *fire*, of the main sentence, **le feu consume et ne produit pas**, *fire consumes and does not produce.*

(5) Indefinite pronouns stand for persons or things of a general or indefinite kind, as **quelqu'un**, *some one*, in **quelqu'un m'a dit**, *some one told me*, or **quiconque**, in **quiconque vous l'a dit**, *whoever told it you.*

(6) Interrogative pronouns are used in questions, and may be described as relative pronouns without an antecedent, or the antecedent of which is implied in the answer to the question ; thus **qui**, in **qui**

en a une ? *who has one ?* may be regarded as a relative pronoun with no expressed antecedent, this antecedent being expected in the answer designating the person having one.

Personal Pronouns. — The personal pronouns are differentiated as either conjunctive or disjunctive ; the former being always the subject or object of a verb, as the nominative **je**, *I*, or the objective **me**, *me ;* but the latter being able to stand by themselves, as **toi**, *thee*, in **tu l'avais cru, toi** ? *thou hast believed it, thou ?* The reflexives **se** and **soi**, *himself, herself, itself*, are sometimes put in a separate class ; **se**, which is always in the objective case, belongs to the conjunctives, and **soi** to the disjunctives, thus—

Il se trompe.	*He deceives himself.*
L'amour de soi.	*Love (of self).*

We may tabulate the personal pronouns as follows :—

Sing.

Nom.	je, *I.*	tu, *thou.*
	il, *he, it.*	elle, *she, it.*
Obj.	me, *me.*	te, *thee.*
	le, *him, it.*	la, *her, it.*
Gen.	en, *of him, her,* or *it.*	
Dat.	me, *to me.*	te, *to thee.*
	lui, *to him, to her.*	y, *to it* or *them.*

Plur.

Nom.	nous, *we.*	vous, *you.*
	ils (m.),	elles (f.), *they.*
Obj.	nous, *us.*	vous, *you.*
	les, *them.*	
Gen.	en, *of them.*	
Dat.	nous, *to us.*	vous, *to you.*
	leur, *to them.*	

Note that **vous** is used, like *you* in English, instead of the second person singular, except in addressing persons who are on terms of great intimacy, or in addresses of an exalted kind, as in prayers and poetical invocations. The adjective that agrees with the pronoun remains, however, in the singular, as in—

Mon ami, vous êtes très heureux.	*My friend, you are most fortunate.*

Be careful not to confuse the pronouns **le, la, les**, with the definite article **le, la, les**, which, of course, always precedes a noun. Do not confuse the pronoun **en**, *of him, her, it,* or *them*, or the adverb **en**, *from thence*, with the preposition **en**, *in*. It is commonly used when in English we should say *some* or *any*, especially in answers to questions, thus—

Avez-vous des souliers de cuir ? J'en ai.	*Have you leather shoes ? I have some* or *I have.*
Votre fils en a-t-il ?	*Has your son any ?*

Note that an adjective used substantively in a partitive sense, in a sentence of this kind, must be preceded by the preposition **de** just as if the noun were expressed, thus—

Avez-vous de bonnes plumes ?	*Have you good pens ?*
Non, j'en ai de mauvaises.	*No, I have bad ones.*

The pronoun **y** means *to this thing, to those things, to that*, and forms the dative of **il, elle, ils, elles**, when these refer to things, not persons. It is also an adverb, as in the sentences—

J'y viens.	*I come there.*
Le soleil y tombait d'aplomb.	*The sun fell there vertically.*

The pronoun **leur**, *to them*, corresponding to **à eux, à elles**, must be distinguished from the possessive adjective **leur**, *their*. The latter alone takes the mark of the plural, thus—

Leur mère, leurs enfants. *Their mother, their children.*

The student could not do better at this stage than to make an effort at French conversation. He should imagine, as below, someone addressing him a question in French, then attempt to reply immediately in French, avoiding to think first of the English words and then translating them. For he must attempt to think in French if he desires ever to become fluent in the language.

As a preliminary to simple conversation the student would be well advised to turn orally all the sentences, for example, in Exercise 11, which are in the first and second person into the third. For instance, he should read aloud the first sentence—Je n'ai aucune raison pour le faire—and immediately turn it into the third person, as an oral exercise—Il n'a aucune raison pour le faire.

French Conversation

Où suis-je ?	Vous êtes ici.
Qui était ici hier ?	L'homme était ici hier, mais l'enfant n'était pas ici.
Aimez-vous cette jeune fille ?	Oui, je l'aime.
Avez-vous vu quelqu'un ?	Je n'ai vu personne.
Votre mère n'a-t-elle pas une robe noire ?	Oui, ma mère a une robe noire.
Quelle heure est-il ?	Il est dix heures moins cinq.
Qui était le roi de France en 1704 ?	Louis Quatorze était le roi de France en 1704.
Aura-t-il demain encore quelques poires ?	Oui, monsieur, il en aura beaucoup.
Avez-vous ses plumes ?	Non, monsieur, je n'ai pas ses plumes.

Où allez-vous ?	Je vais à la maison.
Où est votre père ?	Mon père est à l'église.
Combien de pommes avez-vous ?	J'en ai cinq.
Votre fils, n'est-il pas diligent ?	Oui, monsieur, il l'est (literally, *he is it*).

VOCABULARY

l'acier, m., *steel.*	les mœurs, *manners, morals.*
l'aubergiste, m., *the inn-keeper.*	le parasol, *the parasol.*
le boucher, *the butcher.*	l'or, m., *gold.*
le cheval, *the horse.*	le pays, *the country.*
demain, *to-morrow.*	la pêche, *the peach.*
l'état, m., *the State.*	la poire, *the pear.*
faire, *to do* or *make.*	la raison, *reason.*
les gens, *people.*	la rue, *the street.*
	la viande, *meat.*

Exercise 11

1. Je n'ai aucune raison pour le faire. 2. Avez-vous les objets demandés ? 3. Je n'en ai aucun. 4. Plusieurs gens m'a dit cela. 5. Autres pays, autres mœurs. 6. Avez-vous vu quelqu'un dans la rue ? Personne. 7. Ils auront des raisons quelconques. 8. L'état c'est moi. 9. C'est lui qui j'ai vu ici. 10. J'aime cette femme et j'en suis aimé. 11. Aurez-vous demain encore quelques poires ? 12. Oui, monsieur, j'en aurai beaucoup. 13. Il n'a qu'un parasol. 14. Avez-vous mes livres ou les vôtres ? 15. Cette viande-ci est-elle meilleure que celle-là ? 16. Celle-ci est meilleure que celle-là. 17. Votre sœur n'a-t-elle pas une robe blanche ? 18. Non, elle n'en a pas. 19. Ne les avez-vous pas ? 20. Non, monsieur, nous ne les avons pas.

Exercise 12

1. Have you good horses ? 2. Yes, sir, I have. 3. Have you not my pens ? 4. No, sir, I have not your pens, I have mine. 5. Have you my books or your own ? 6. I have neither yours nor mine. 7. Has not your brother black shoes ? 8. No, he has none. 9. Who has one ? 10. Who has none ? 11. Has not the butcher any fresh meat ? 12. He has plenty. 13. He has scarcely any. 14. Has that gentleman a good steel pen or a fine gold one ? 15. He has a steel one and we have a gold one. 16. How many pears have you ? 17. We have enough. 18. He has something good and bad. 19. He has nothing good. 20. You have but few peaches.

Key to Exercise 5

1. The poor child has a good mother. 2. That man is a good father to his children. 3. I have seen several soldiers. 4. It is a great pity. 5. My son is a pretty boy. 6. All the school-children are very amiable children. 7. Your tailor is very obliging. 8. There is my children's governess. 9. We are a very happy family. 10. The whole city is very uneasy. 11. That boy and that pretty girl are twins. 12. I have an aged father and a step-mother who is not very old. 13. That handsome coat is made of woollen cloth. 14. I have a handsome silk dress. 15. The cock is a white bird, but the hen is black. 16. This Turkish town is a powerful fortress. 17. I am entirely frank with you, be frank with me. 18. The morning air is fresh enough. 19. The leaves are not young and fresh, but rather old and dry. 20. My daughter-in-law is a good worker.

Key to Exercise 6

1. Avez-vous un garçon diligent et une fille diligente ? 2. Mon garçon est diligent, mais ma fille est paresseuse. 3. Cette coutume est elle ancienne ? 4. Cette coutume n'est pas ancienne, elle est nouvelle. 5. Votre plume est-elle bonne ou mauvaise ? 6. Ma sœur est très vive. 7. Votre fille est-elle contente ? 8. Votre cousine est-elle heureuse ? 9. Oui, elle est bonne, belle, et heureuse. 10. Votre sœur a-t-elle une robe neuve et des souliers neufs ? 11. J'ai de vieux souliers et une vieille robe. 12. Non, je n'ai ni sommeil ni faim. 13. Votre frère n'a-t-il pas un bel habit ? 14. Avez-vous de bonne viande, monsieur ? 15. J'ai de la viande excellente. 16. Votre ami a-t-il un bel encrier ? 17. Son encrier est beau, mais il n'est pas de porcelaine. 18. Quelqu'un a-t-il faim ? 19. Personne n'a faim. 20. Les généraux sont-ils ici ?

Key to Exercise 7

1. Both the father and the mother are very amiable. 2. Give me new dresses and shoes. 3. It is a strange thing. 4. Victor was a young poet of the city. 5. My son and daughter are very pleased. 6. You are a foolish child. 7. We have a pretty little house. 8. Never had he seen a more extraordinary or more beautiful head. 9. He saw a big person enveloped in a black velvet cloak. 10. She admired the smallest objects with a little knowing air. 11. He is a regular barbarian. 12. The simplest and most natural way. 13. She had a charming appearance, enhanced by her bizarre costume. 14. This atrocious animal is very jealous. 15. He is a brave man as well as quite a rascal. 16. I often saw him last year. 17. Give it to me, it is a true diamond.

Key to Exercise 8

1. Il est aussi heureux que vous. 2. Avez-vous plus d'assiettes que de plats ? 3. Est-il plus complaisant que ses frères ? 4. Le jardinier a-t-il moins de légumes que de fruits ? 5. Il a moins de livres que de manuscripts. 6. Je n'ai plus de livres. 7. Je n'ai plus de chocolat. 8. Je n'ai guère d'amis. 9. Votre marchand est bien obligeant. 10. Voilà le meilleur de ces garçons. 11. Nous avons encore des amis. 12. Vous avez encore du crédit. 13. Avez-vous encore une piastre ? 14. Le maçon a-t-il encore des briques ? 15. Il n'a plus de briques. 16. Je n'ai guère de livres. 17. Combien de piastres avez-vous encore ? 18. Je n'ai plus d'argent, mais j'ai encore du crédit. 19. A-t-il autant de pain que de fromage ? 20. A-t-il autant d'amis que d'ennemis ?

Key to Exercise 9

1. We have nearly two million soldiers at the front. 2. Two thousand four hundred and thirty men are dead. 3. I have a million francs. 4. The year 1897. 5. Louis XIV. was king of France in the year 1704. 6. To-day is the last day of the month. 7. I have more than three thousand volumes in my library. 8. I have a dozen pairs of silk stockings in my shop. 9. It is ten minutes past nine. 10. It is a quarter to ten. 11. What day is it ? 12. It is the first of February. 13. What day of the month is it ? It is the eighteenth. 14. How old are you ? 15. I am seventeen years and six months old. 16. Have you more than eighty litres of that wine ? 17. This man is one of the biggest rogues. 18. Is this fine house the property of your brother ? 19. Your father's death is a great misfortune for all. 20. Their efforts are entirely useless. E. A. B.

GERMAN.—IV

THE student will have noticed that when an adjective is used predicatively, i.e. when it is separated from the noun it qualifies by a verb, it is not inflected in any way. But when an adjective is used attributively, i.e. placed before a noun, it is inflected for gender, number, and case, agreeing with the noun it qualifies.

Adjectives.—Preceded by **der, die, das,** and certain other words, namely **dieser, jener, jeder, welcher, mancher,** the terminations affixed to the adj. are as follows :—

	Sing.		
	Mas.	*Fem.*	*Neut.*
Nom.	**e**	**e**	**e**
Acc.	**en**	**e**	**e**

In all other cases and in the whole plural the ending **en** is added.

Examples :—

Nom.	der gut-**e** Vater,	die gut-**e** Mutter,	das gut-**e** Kind.
Gen.	des gut-**en** Vaters,	der gut-**en** Mutter,	des gut-**en** Kindes.
Dat.	dem gut-**en** Vater,	der gut-**en** Mutter,	dem gut-**en** Kind(e).
Acc.	den gut-**en** Vater,	die gut-**e** Mutter,	das gut-**e** Kind.

In the plur. in all cases for all genders, gut-**en.**

When preceded by **ein, eine, ein,** and certain other similar words, namely, **mein, dein, sein, ihr, unser, euer, Ihr,** and **kein,** the terminations affixed to the adj. are as follows :—

	Sing.		
	Mas.	*Fem.*	*Neut.*
Nom.	**er**	**e**	**es**
Acc.	**en**	**e**	**es**

In all other cases and in the whole plural the ending is **en.**

Examples

Nom.	ein gut-**er** Vater,	eine gut-**e** Mutter,	ein gut-**es** Kind.
Gen.	eines gut-**en** Vaters,	einer gut-**en** Mutter,	eines gut-**en** Kindes.
Dat.	einem gut-**en** Vater,	einer gut-**en** Mutter,	einem gut-**en** Kind(e).
Acc.	einen gut-**en** Vater,	eine gut-**e** Mutter,	ein gut-**es** Kind.

In the plur. in all cases for all genders, gut-**en.**

Otherwise when adjectives are used attributively they are declined like **dieser, diese, dieses.**

However, in the gen. sing. mas. and neut. the termination **en** is usually preferred in modern German to **es.**

Examples : guter Mut (moot), *good courage ;* gute Milch (milch), *good milk ;* gutes Wasser (vassər), *good water ;* gute Menschen, *good people,* are declined as follows :—

	Mas.	*Fem.*
Nom.	gut-**er** Mut	gut-**e** Milch
Gen.	gut-**es** or gut-**en** Mutes	gut-**er** Milch
Dat.	gut-**em** Mute	gut-**er** Milch
Acc.	gut-**en** Mut	gut-**e** Milch
	Neut.	*Plur.*
Nom.	gut-**es** Wasser	gut-**e** Menschen
Gen.	gut-**es** or gut-**en** Wassers	gut-**er** Menschen
Dat.	gut-**em** Wasser	gut-**en** Menschen
Acc.	gut-**es** Wasser	gut-**e** Menschen

Mixed Declension of Nouns.—A small number of masculine and neut. nouns are declined in the sing. according to the strong declension, and in the plur. according to the weak, thus :—

Nom. Sing.	*Gen. Sing.*	*Plur.*
der Dorn (dorn), *the thorn*	des Dorns	die Dornen
der Mast (mast), *the mast*	des Mastes	die Masten
der Lorbeer (lor-bayr), *the laurel*	des Lorbeers	die Lorbeern
der Muskel (mus-kəl), *the muscle*	des Muskels	die Muskeln
der Nachbar (nahkbahr), *the neighbour*	des Nachbars	die Nachbarn
der Pantof'fəl (pan-tof'fəl), *the slipper*	des Pantoffels	die Pantoffeln
der Schmerz (shmayrts), *the pain*	des Schmerzes	die Schmerzen
der See (zay), *the lake*	des Sees	die Seen
der Sporn (shpohrn), *the spur*	des Sporns	die Sporen
der Staat (shtaht), *the state*	des Staats	die Staaten
der Stachel (shtahkəl), *the spine, thorn*	des Stachels	die Stacheln
der Stiefel (shtee-fəl), *the boot*	des Stiefels	die Stiefeln
der Strahl (shtrahl), *the ray*	des Strahls	die Strahlen
der Un'tertan (un'-tərtahn), *the subject*	des Untertans	die Untertanen
der Vetter (fettər), *the male cousin*	des Vetters	die Vettern
das Auge (owgə), *the eye*	des Auges	die Augen
das Bett (bet), *the bed*	des Bettes	die Betten

das Ende (endə), *the end*	des Endes	die Enden
das Hemd (hemt), *the shirt*	des Hemdes	die Hemden
das Ohr (ohr), *the ear*	des Ohrs	die Ohren

Ten mas. nouns ending in **e** and one neut., das Herz (hayrts), *the heart*, form the gen. sing. in **ens**, and the rest of the cases sing. and plur. in **en** according to the weak declension. Some of these mas. nouns have an alternative form in the nom. sing. ending in **en.**

Nom. Sing.	*Gen. Sing.*	*Plur.*
Buch'stabe (book'-shtahbə), *letter*	Buchstabens	Buchstaben
Drache(n) (drakə), *dragon, kite*	Drachens	Drachen
Fels(en) (fels), *rock*	Felsens	Felsen
Friede(n) (freedə), *peace*	Friedens	Frieden
Funke(n) (funkə), *spark*	Funkens	Funken
Gedanke (gədankə), *thought*	Gedankens	Gedanken
Glaube(n) (glowbə), *faith*	Glaubens	Glauben
Haufe(n) (howfə), *heap*	Haufens	Haufen
Name(n) (nahmə), *name*	Namens	Namen
Same(n) (zahmə), *seed*	Samens	Samen
Schreck(en) (shreck), *fright*	Schreckens	Schrecken
Wille(n) (villə), *will*	Willens	Willen
Herz, *heart*	Herzens	Herzen

The student is advised to write out in full the declension of the following :—

Sing.	*Plur.*
der schöne Tag, *the fine day*	die schönen Tage
ein starker Baum (shtarkər bowm), *a strong tree*	starke Bäume (boymə), *strong trees*
die reife Birne (ryfə birnə), *the ripe pear*	die reifen Birnen
keine gute Nach'richt (nahk'-richt), *no good news*	keine guten Nachrichten
ihr warmes Herz (varməs hayrts), *her warm heart*	ihre warmen Herzen
ein rotes (rohtəs) Buch, *a red book*	rote Bücher
dieses alte Pferd (pfayrt), *this old horse*	diese alten Pferde
jener starke Wille, *that strong will*	jene starken Willen
der blaue (blowə) See, *the blue lake*	die blauen Seen
grosze Kälte (keltə), *great cold*	grosze Kälten
guter Wein (vyn), *good wine*	gute Weine

Almost all adjectives can be used as adverbs in their uninflected form.

VOCABULARY

schwer (shvayr), *heavy.*
grau (grow), *grey.*
jung (yungk), *young.*
blond (blont), *fair, blonde.*
Page (pahzhe), w.m., *page* (a youth).
leicht (lycht), *light, free from care.*
er trug (troog), *he bore.*
Sinn (zin), s.m.2, *mind, temperament.*
seiden (zydən), *silken.*
Königin (königin), w.f., *queen.*
Lied (leet), s.n.3, *song.*
süsz (züss), *sweet.*
sie muszten (musstən), *they must, they had to.*
sterben (shtayrbən), *to die.*
Haupt (howpt), s.n.3, *head.*
so (zoh), *so.*
Schleppe (shleppə), w.f., *train.*
Kennst du (kenst doo), *dost thou know?*
es klingt (klingt), *it sounds.*
trübe (trübə), *sad, mournful.*
beide (bydə), *both.*
sich lieb haben (zich leep hahbən), *to love one another.*

Exercise 13

Es war ein alter König,
Sein Herz war ſchwer, ſein Haupt war grau;
Der arme alte Körig,
Er nahm eine junge Frau.

Es war ein ſchöner Page[1],
Blond war ſein Haupt[2], leicht war ſein Sinn[3];
Er trug die ſeidne[4] Schleppe
Der jungen Königin[5].

Kennſt du das alte Liedchen[6]?
Es klingt ſo ſüß[7], es klingt ſo trüb.
Sie mußten beide[8] ſterben[9],
Sie hatten ſich viel[10] zu lieb.

H. Heine.

NOTES :—

(1) Page: the sound of the g in this word we have indicated in the vocabulary by zh; it bears the same relation to sh as z does to s, that is to say, whereas sh and s are hard sounds, zh and z are soft sounds. This pronunciation of g in German only occurs in words borrowed from the French, and it is exactly the same as a soft French g as in *manger*. The nearest we can get to it in English is the sound of the g in *judge* if we pronounce dg without the d before it. (2) Blond war ſein Haupt: this is an inversion of the normal order such as we often find in English verse too, e.g. "Into the jaws of death rode the six hundred," instead of the normal: the six hundred rode. But in English the inversion is optional, whereas in German it is obligatory, since the sentence does not begin with the subject.

(3) Leicht war ſein Sinn (*see* note 2). (4) ſeidne: adjectives ending in **el, en, er** usually reject the **e** of these endings before the **e** of the declensional termination. (5) Königin: **in** is a fem. termination added to mas. nouns denoting persons of the male sex, to form nouns denoting the female. These nouns all belong to the weak declension, and they double the **n** of **in** before the **en** of the termination. Thus, sing. Königin, plur., Königinnen. The stem vowel of the noun to which the **in** is added is usually modified, e.g. Graf (grahf), *count*; Gräfin (grayfin), *countess*. (6) Liedchen. This is a diminutive of Lied, and is a strong noun of class 1. (7) ſüß, trüb: these are adjectives used in their uninflected forms as adverbs. The full form of trüb is trübe, as given in the Vocabulary; adjectives ending in **e** often drop this final **e** in verse and also in colloquial speech. (8) beide: when beide qualifies the subject it is usually placed immediately after the finite verb. It can be used as an adjective, in which case it always precedes the noun it

qualifies and follows the pronoun it qualifies; thus, die beiden Häuſer, *both the houses*. It is never followed by a gen. as in English, e.g. mit uns beiden, *with both of us*. (9) ſterben: the infinitive is placed at the end of the clause (*see* note 1, Exercise 11). (10) Sie hatten ſich lieb: literally, *they held* (had) *each other dear*; ſich is the reflexive as well as the reciprocal pronoun of the 3rd pers. mas., fem., neut., sing. and plur., just like *se* in French.

Exercise 14

Answer the following questions in German :—

1. Wie war der König? 2. Wie war ſein Herz? 3. Wie war ſein Haupt? 4. Was tat er? 5. Wie war der Page? 6. Was tat er? 7. Wie war die Schleppe der Königin? 8. Warum mußten ſie beide ſterben?

Exercise 14a

Translate into German :—

1. My heart is heavy. 2. The poor king was old. 3. His wife was young. 4. You were a beautiful young page. 5. She had a silken train. 6. Their songs are old and sweet. 7. It sounds sad. 8. Dost thou know these sad songs? 9. His head is grey, but her head is fair.

Demonstrative Adjectives and Pronouns

In addition to **dieser** and **jener** (*see* Lesson 2), the following can be used as demonstrative adjectives: **der, derjenige** (dayrjaynigə), *that*, and **derselbe** (dayrselbə), *the same*.

Derjenige, diejenige, dasjenige, and derselbe, dieselbe, dasselbe are declined in both parts, the first part like the def. art. and the second like any adj. after the def. art. (*see* the beginning of this Lesson). Thus, *of that man* is desjenigen Mannes, *to the same woman* is derselben Frau.

All the above can be used as demonstrative pronouns as well. They are declined in exactly the same way when they are used as pronouns except der, die, das, *that*, which differs from the def. art. in the following cases :—

	Sing.			*Plur.*
	Mas.	*Fem.*	*Neut.*	
Gen.	dessen	deren	dessen	derer or deren
Dat.	—	—	—	denen

Relative Pronouns are der and welcher, *who, which, that*. Der as a relative is declined like der demonstrative; welcher borrows the gen. sing. and plur. of the demonstrative der, but is declined otherwise like the adj. welcher (*see* Lesson 2).

These rel. pronouns, of course, always introduce dependent clauses, and in every dependent clause the finite verb is placed at the end. Thus, *Here is the man who bought our house* is, in German, Hier ist der Mann der (or welcher) unser Haus kaufte. The student should carefully note the difference between the order of the words in English and German.

There is an indeclinable neut. rel. pron. was, what = that, which.

Exercise 15

1. Hier iſt dasjenige Buch welches Sie geſtern ſuchten. 2. Die Frau deren Tochter hier war iſt oben. 3. Der Mann der Ihre Stiefel holt iſt derſelbe dem ich geſtern Geld gab. 4. Wir hören nicht den Lärm den Sie hören. 5. Sie ſuchten den Garten in dem die Äpfel ſind. 6. Der Gärtner deſſen Haus ich kaufte iſt nicht hier. 7. Dort in jener Straße ſind die Häuſer in denen wir wohnen. 8. In denjenigen Gärten arbeiteten die Mädchen deren Briefe wir ſuchten.

9. Here is the water that you were looking for. 10. There is the man whose sisters live in that town. 11. The manservant who fetched my boots is not here. 12. There is that porter to whom he gave the money. 13. He is fetching the letters that you are looking for. 14. Where is the hat that she bought yesterday? 15. That hat that she is looking for is downstairs. 16. Those men to whom he gave the books live here. 17. The women whose children were here are upstairs.

The names of the months are as follows: —Jan'uar (yan'ooahr), Fe'bruar (fay'brooahr), März (merts), April' (april'), Mai (my), Ju'ni (yoo'nee), Ju'li (yoo'lee), August' (owgust'), Septem'ber (septem'bər), Okto'ber (oktoh'bər), Novem'ber (nohvem'bər), Dezem'ber (daytsem'bər).

The names of the days of the week are :— Sonn'tag (zon'tahg), Mon'tag (mohn'tahg), Dien'stag (deen'stahg), Mitt'woch (mit'vo*k*), Don'nerstag (don'nərstahg), Frei'tag (fry'tahg), Sonn'abend (zon'ahbənt).

The form Sonnabend, which means *the eve of the sun*, i.e. of Sunday, is in vogue in North Germany; in the South, Saturday is usually called Sams'tag (zams'tahg).

Montag is *the day of the moon*, der Mond (mohnt), Mittwoch, Wednesday, is really *the middle of the week*, die Mitte, *the middle*, and die Woche (vo*k*e), *the week*.

Key to Exercise 9

1. Die Krähe sagte einen Grusz. 2 Der Grusz war " Heil Kaiser und Sieger." 3. Ja er hatte drei andere Vögel. 4. Si sagten auch den Grusz. 5. Der Schuster lebte in Rom. 6. Nein die Krähe lernte langsam. 7. Ja er wurde müde. 8. Er sagte dann " Meine Zeit und meine Mühe sind verloren." 9. Ja sie lernte den Grusz. 10. Ja er brachte sie dem Kaiser. 11. Er sagte " Ich habe drei Vögel zu Hause, sie sagen auch diese Worte." 12. Der Vogel sagte darauf " Meine Zeit und meine Mühe sind verloren." 13. Er lachte und nahm die Krähe und gab dem Schuster viel Geld.

M. A. L.

Continued from page 366

GEOGRAPHY:

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EARTH AND MOON

ALTHOUGH the Moon is relatively speaking a very small body, being only one eighty-first part of the size of the Earth and about one twenty-seven millionth of the size of the Sun, yet owing to its proximity to the Earth it has a very great effect from the point of view of its gravitational influence.

Theory of Eclipses

During the course of the year the Moon varies in distance from the Earth from 221,614 miles, when it subtends an angle of about 33½° at the earth, to 238,840 miles, when it subtends an angle of about 29½°. As an eclipse of the Sun is caused by the passage of the Moon between the Sun and the Earth, it is clear that a total eclipse of the Sun is only possible when the Moon's area appears larger than that of the Sun, i.e. when the moon is at its nearest point to the Earth or, as it is called, in *perigee*. If the Moon passes directly between the Earth and the Sun when the Moon is at its farthest point away or, as it is called, in *apogee*, the eclipse is *annular*, that is, there is at the period of greatest obscuration a ring of light all round the dark body of the Moon. If it so happens that the Moon does not pass directly between the Earth and the Sun, but is a little to one side, then there may be a partial eclipse of the sun.

As the shadow of the Earth cast by the Sun forms a huge cone of darkness averaging 857,000 miles in length, it is clear that when the Moon, which is distant only about 240,000 miles from the Earth, passes into this shadow it will become eclipsed. The phenomenon can easily be understood by reference to Fig. 23.

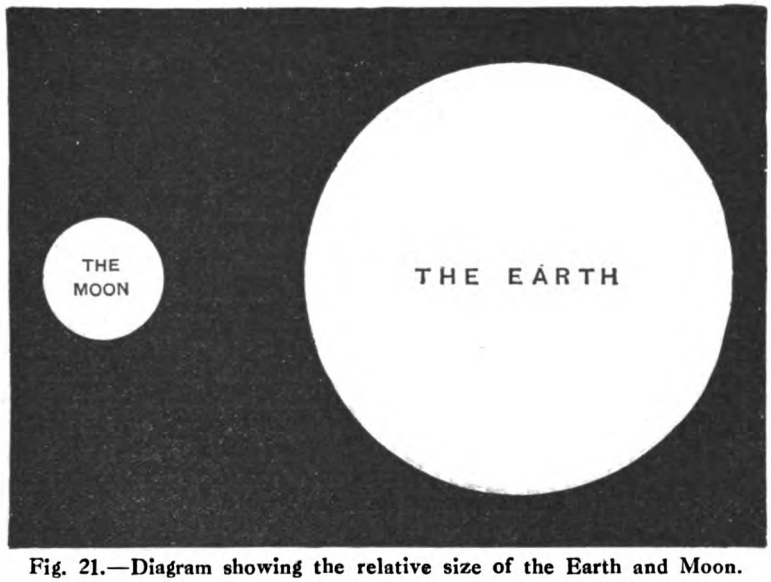


Fig. 21.—Diagram showing the relative size of the Earth and Moon.

If the Moon travelled in the path of the *Ecliptic* (the apparent path followed by the Sun through the stars) there should be an eclipse of the Sun every time the Moon is "new," but since the orbit of the Moon is inclined to that path at an angle of about 5 degrees, eclipses are only possible near the *node* or crossing of the two apparent paths.

Under the most favourable conditions an actual eclipse of the Sun can only last for 7 minutes 40 seconds. That of the Moon, owing to the large shadow of the Earth, may last for about two hours.

Since the Moon shines by reflected sunlight, the amount of its surface that is visible depends upon her continually changing position with regard to the Sun and Earth. Full and New Moon occur when the Sun and Moon are respectively opposite and on

the same side of the Earth. In the first and fourth quarters the Moon is said to be crescent, and in the second and third quarters it is said to be gibbous.

Tides and their Origin

The tides in the ocean are caused by the action of the force of gravity exerted by the Sun and the Moon. In consequence of its relative nearness to the Earth, the force exerted by the Moon is about 2½ times greater than that due to the Sun, in spite of the latter's greater mass.

Now the Earth may be considered as consisting of two different parts with different physical properties, namely, the Land and the Sea. Both of these, of course, are acted upon by gravity, but whereas the land can only move as a whole in response to the pull exercised upon it, the waters of the sea can move independently of the land. The land cannot assume a new shape under the action of gravity, but the water can do so.

If for a moment we consider that the Earth is at rest and completely covered by water, we can see that, as in Fig. 24, the water on the top side is nearer to the Moon than is the centre of the Earth (which is the point at which the whole mass of the Earth acts), and that the centre of the Earth is nearer to the Moon than is the water on the bottom side of the diagram. Thus the attraction of the Moon will pull up into a heap the waters on the top side (*a*) away from the Earth, and will also pull the Earth away from the waters on the bottom side (*b*) of the diagram.

The water is consequently piled up under the Moon and also piled up on the opposite side of the Earth. Necessarily, also, the water is depressed at right angles to these parts (*c*), (*d*). Thus while under the Moon and at the opposite side of the Earth we shall have "high tide," in places at right angles to these parts we shall have "low tide." This explanation is known as the "Equilibrium Theory" of the Tides. If this explanation has been followed it will be seen that high tide at any place should occur immediately the Moon is on the meridian (i.e. directly above) that place. But owing to disturbing causes, such as the irregularity of the land surface of the Earth, friction between the water and the bed of the sea, etc., the actual time of high tide occurs some days after the Moon has crossed the meridian. In the British Isles the difference varies from three days to four or even five days on different parts of the coast.

Now, it has been said that the force of gravitation due to the Moon is 2½ times greater than that due to the Sun. This should cause us to reflect that although the Moon is the prime cause of the tides, yet the Sun must have some effect. We find that this is so. And the fact that the Sun acts on the water in exactly the same way as does the Moon accounts for the fact that the tides are not always of the same height. It should be obvious that if the Moon and the Sun are exerting their force in the same direction—that is to say, as they do at full moon and new moon—the tides should be higher then than at other times. Also that if the Moon and the Sun are exerting their force at right angles to one another, as they do at the first and third quarters, the tides should be lower than at other times. This supposition is borne out by the facts. We find that at the full and new moon there are the highest tides (Spring tides), whereas at the first and third quarters there are the lowest tides (Neap tides).

Another controlling cause of the variations in the height of the tides is the fact

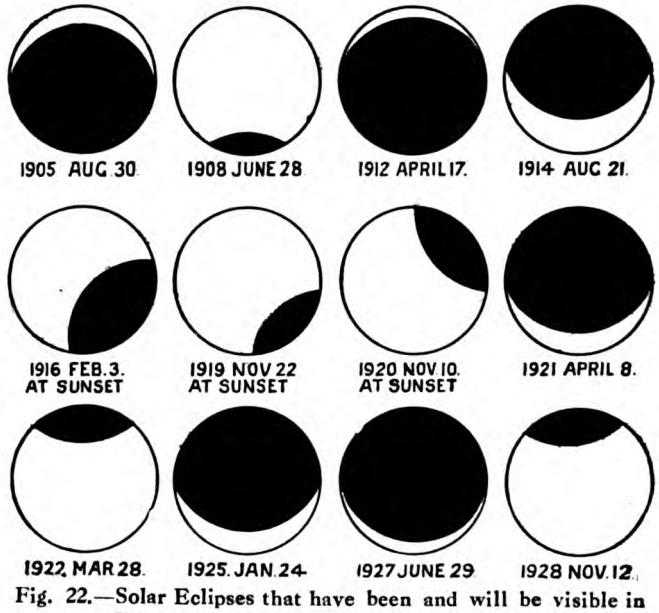


Fig. 22.—Solar Eclipses that have been and will be visible in Britain between 1905 and 1928 inclusive.

that at certain times of the year (when the Moon is in perigee) the attraction is greater than at other times owing to its nearness to the Earth. This causes extra high tides, and they occur in March and September. In June and December, when the Moon is farthest away from the Earth,

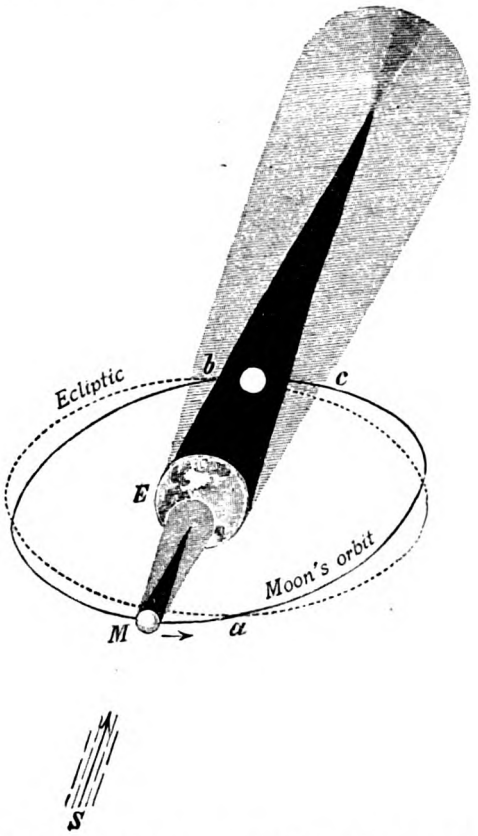


Fig. 23.—The shadow of the Earth (E) cast by the Sun (S) forms a cone of darkness, 857,000 miles in length, and the Moon (M), passing through it, is eclipsed.

the high tides are not so high as usual. The extra-high high tides are known as Equinoctial tides; the extra-low high tides are the Solstitial tides.

Tidal Rivers

The difference in the height of the water at high tide and that at low tide in the open sea far from land is comparatively small, being not more than three feet. In the great inland seas such as the Mediterranean and the Caspian, and also in the great lakes of North America, the tides, though they exist, are nearly imperceptible. Where the estuary of a tidal river contracts rapidly, however, the tides rushing up it increase very rapidly from the mouth towards the source. Thus in the Bristol Channel the highest spring tides are about 18 feet, at Swansea they rise to about 30 feet, and at Chepstow, still farther up the Channel, they attain a height of as much as 50 feet.

It will be interesting in this connection to consider the movements of the tidal waters surrounding the British Isles, as this will help to explain how it is that although the height of the tidal wave far out in the ocean is but some three or four feet, yet round the shores of our country we see the tide rising to heights far greater than this.

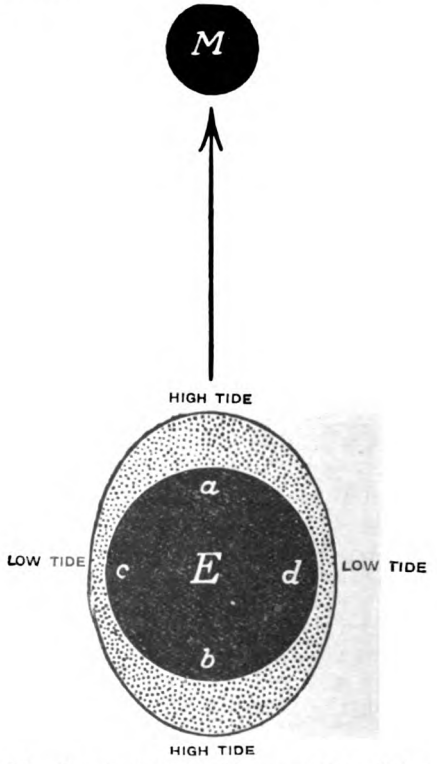
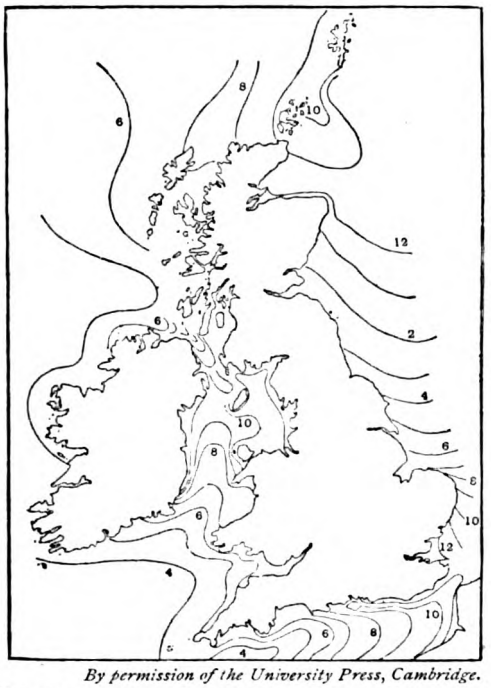


Fig. 24.—Showing how tides are formed by the force of gravity exerted by the Moon (*see* p. 425).

This phenomenon is due primarily to the fact that the British Isles are situated on the "continental shelf" of Europe. In the mid-Atlantic, at intervals of about twelve hours, there passes each point a vast wave, as we have seen about 3 feet high, measuring, however, from trough to trough several thousand miles. This wave is carried rapidly forward (without, however, any transference of water) at a rate of several hundred miles an hour.

When it arrives at the edge of the continental shelf it is rapidly checked on passing into the shallower water, and its speed



By permission of the University Press, Cambridge.

Fig. 25.—Co-tidal lines of the British Seas. The figures indicate time in hours.

is reduced to under a hundred miles an hour. The shape of the wave also is altered, as the crest tends to move more quickly than the trough it is following. Also when the water has become so shallow as to bear some relation to the height of the wave itself, it is clear that to allow the surface to rise a body of water must be drawn from the deeper sea into the shallows. This forms a tidal current or actual transference of water from one part of the sea to another. Thus we find flowing between the Orkney Islands and the mainland of Caithness, through the Pentland Firth, an alternating tidal race running with a speed of from six to ten knots an hour.

When it strikes the west coast of Ireland the tide flows round the British Isles, passing on the one side up the English Channel and the St. George's Channel and on the other side through the Pentland Firth and the North Channel. This causes the time of high water to be the same just east of the Pentland Firth, at Liverpool and at Dover.

The shallow waters of the North Sea cause a retardation of the flow of the tide and the northern tide coming down the east coast of Scotland and England brings high water successively later at each port, taking about twelve hours to reach the Thames, the rate being thus about fifty miles an hour.

The southern tide coming up the English Channel and through the Straits of Dover passes along the Belgian and Dutch coasts and causes high-water at Heligoland at the time the next tide following has reached Dover.

The complexity of the tides when considered in detail is much enhanced by local peculiarities of the contour of the coast. Thus the Isle of Wight, lying off Southampton Water, has the effect of causing four tides a day at the port of Southampton, owing to the fact that the tidal wave rounding the east end of the island and passing up the Spithead is two hours later than that entering the Solent.

Many estuaries are turned by the tides into arms of the sea and thus have rendered possible the establishment of a port where, but for this, there would not be sufficient water to take vessels of any great draught.

C. J. S.

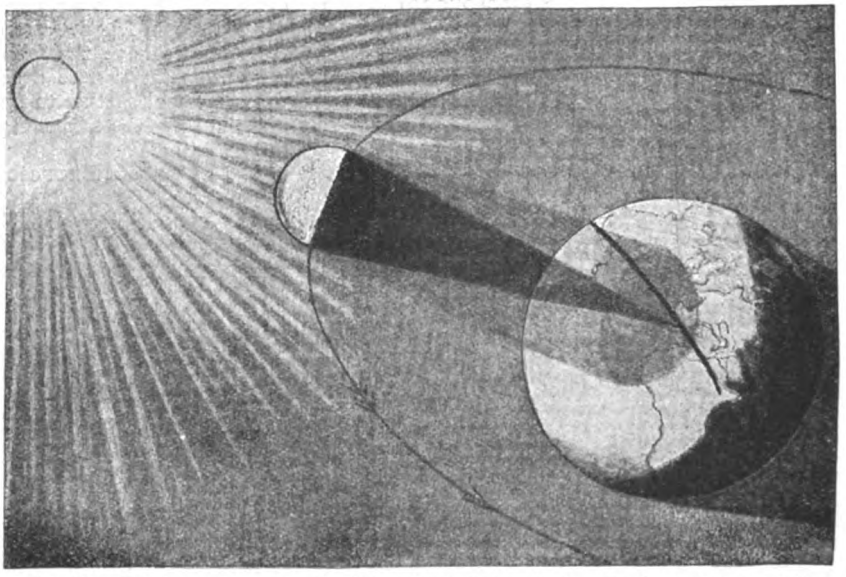


Fig. 26.—Diagram showing the Moon's shadow on the Earth during a total eclipse of the Sun.

Continued from page 375.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.

(M. A. Lewenz, M.A.[Lond.]).

ARITHMETIC.—VII

65. To divide by a fraction.—The student will remember that when we were dealing with division (§ 23) we found that divisor × quotient (+ remainder) = dividend.

When the divisor is a fraction, we have to discover what number we must multiply by this fraction in order to produce the dividend.

Thus to divide $\frac{2}{7}$ by $\frac{3}{5}$,

The divisor is $\frac{3}{5}$, the dividend is $\frac{2}{7}$,

The required quotient $\times \frac{3}{5} = \frac{2}{7}$

$\therefore$ the required quotient $\times \frac{3}{5} \times \frac{5}{3} = \frac{2}{7} \times \frac{5}{3}$.

But $\frac{3}{5} \times \frac{5}{3} = 1$

$\therefore$ required quotient $\times 1 = \frac{2}{7} \times \frac{5}{3}$

$\therefore$ required quotient $= \frac{2}{7} \times \frac{5}{3} = \mathbf{\frac{10}{21}}$.

When we have two fractions such that the numerator of each is the denominator of the other, the one fraction is called the **Reciprocal** of the other.

Thus the reciprocal of $\frac{2}{3}$ is $\frac{3}{2}$, and the reciprocal of $\frac{1}{5}$ is $\frac{5}{1}$, i.e. 5.

Hence we get the following rule.

To divide by a fraction is to multiply by its reciprocal.

As in multiplication of fractions, so in division all mixed numbers must first be reduced to improper fractions.

Example :—

Divide $2\frac{1}{4}$ by $1\frac{7}{8}$.

$$2\tfrac{1}{4} \div 1\tfrac{7}{8} = \frac{9}{4} \div \frac{15}{8} = \frac{\cancel{9}^{3}}{\cancel{4}_{1}} \times \frac{\cancel{8}^{2}}{\cancel{15}_{5}} = \frac{6}{5} = \mathbf{1\tfrac{1}{5}}.$$

66. A complex fraction is one in which either the numerator or the denominator or both are fractional.

Thus $\frac{2\frac{1}{4}}{1\frac{7}{8}}$, $\frac{3\frac{1}{2}}{7}$, $\frac{1}{5\frac{2}{3}}$, $\frac{\frac{2}{3}+\frac{3}{4}}{\frac{1}{9}\text{ of }\frac{2}{5}}$ are complex fractions.

It will simplify our comprehension of a complex fraction if we remember that a fraction may always be looked upon as a quotient; we consequently treat all such as quotients.

Thus $\frac{2\frac{1}{4}}{1\frac{7}{8}} = 2\frac{1}{4} \div 1\frac{7}{8} = \frac{9}{4} \times \frac{8}{15} = \frac{6}{5} = \mathbf{1\tfrac{1}{5}}$.

$\frac{3\frac{1}{2}}{7} = 3\frac{1}{2} \div 7 = \frac{7}{2} \times \frac{1}{7} = \mathbf{\frac{1}{2}}$.

$\frac{1}{5\frac{2}{3}} = 1 \div 5\frac{2}{3} = 1 \times \frac{3}{17} = \mathbf{\frac{3}{17}}$.

A complex fraction should always be reduced to the form of one fraction over another, before we proceed to division.

Thus $\frac{\frac{2}{3}+\frac{3}{4}}{\frac{1}{9}\text{ of }\frac{2}{5}} = \frac{\frac{8+9}{3\times 4}}{\frac{2}{5\times 9}} = \frac{17}{3\times 4} \div \frac{2}{5\times 9}$

$= \frac{17}{\frac{3}{1}\times 4} \times \frac{5\times \frac{3}{9}}{2} = \frac{17\times 5\times 3}{2\times 4} = \frac{255}{8} = \mathbf{31\tfrac{7}{8}}$.

When a complex fraction has been reduced to the form of one fraction over another, the numerator of the top fraction and the denominator of the bottom fraction are called the **extremes**; the denominator of the top fraction and the numerator of the bottom fraction are called the **means.**

Hence we have the following rule: To reduce a complex fraction to a simple fraction multiply the extremes together to form the new numerator, and multiply the means together to form the new denominator.

Exercise 20

Simplify :

(1) $\frac{7}{5} \div \frac{5}{8}$; (2) $\frac{21}{25} \div \frac{7}{15}$; (3) $\frac{105}{115} \div \frac{35}{55}$; (4) $7\frac{1}{5} \div 2\frac{2}{7}$; (5) $6\frac{9}{11} \div 25$; (6) $32 \div 1\frac{3}{17}$; (7) $2\frac{38}{121} \div 9\frac{5}{11}$; (8) $9\frac{1}{16} \div 7\frac{3}{7}$.

Divide :

(9) $\frac{3}{8}$ of $\frac{12}{25}$ of $\frac{5}{9}$ by $\frac{2}{7}$ of $\frac{3}{8}$ of $8\frac{3}{4}$ of $5\frac{1}{7}$.

(10) $\frac{1}{11}$ of $5\frac{5}{6}$ of $6\frac{3}{5}$ of $2\frac{1}{7}$ by $\frac{4}{13}$ of $7\frac{4}{5}$ of $\frac{1}{6}$ of 25.

Reduce to simple fractions :

(11) $\frac{1\frac{61}{64}}{1\frac{9}{15}}$ (12) $\frac{1\frac{13}{15}}{2\frac{59}{68}}$ (13) $\frac{\frac{1}{5}\text{ of }2\frac{1}{8}}{\frac{2}{11}\text{ of }\frac{7}{64}}$ (14) $\frac{\frac{1}{2}+\frac{1}{3}}{\frac{1}{2}-\frac{1}{3}}$

We will work out one or two rather more complicated complex fractions, to familiarise the student with the method of dealing with them.

The student is warned once more to remember the following rules in working out examples :

(*a*) Multiplications and divisions must be performed in order from **left** to **right.**

(*b*) Quantities connected by *of* must be regarded as **single quantities.**

(*c*) All **compound** and **complex** fractions must be reduced to *single* fractions before any operations of addition or subtraction are performed with them.

(*d*) All operations of **multiplication** and **division** must be performed **before** those of **addition** and **subtraction,** except when terms connected by the signs + and − are in brackets, in which case the terms in brackets must be reduced to a simple fraction before operating with them.

Example (1):—

$$\frac{\frac{1}{3}\text{ of }\frac{1}{2}+\frac{3}{5}\text{ of }5}{9\frac{1}{3}-1\frac{2}{3}}=\frac{\frac{1}{6}+\frac{15}{7}}{7\frac{2}{3}}=\frac{\frac{1+45}{6}}{\frac{23}{3}}$$

$$=\frac{46}{6}\div\frac{23}{3}=\frac{\overset{1}{\cancel{46}}}{\underset{1}{\cancel{6}}}\times\frac{\overset{1}{\cancel{3}}}{\underset{1}{\cancel{23}}}=\mathbf{1}.$$

Example (2):—

$$\frac{4\frac{1}{4}-3\frac{3}{8}}{4\frac{1}{4}+3\frac{3}{8}}+\frac{3-2\frac{1}{3}}{4-3\frac{1}{4}}\times\frac{\frac{5}{8}}{2\frac{1}{2}\text{ of }1\frac{1}{3}}$$

$$=\frac{\frac{7}{8}}{7\frac{3}{8}}+\frac{\frac{2}{3}}{\frac{3}{4}}\times\frac{\frac{5}{8}}{\frac{5}{2}\times\frac{4}{3}}\ 2$$

$$=\frac{\frac{7}{8}}{\frac{61}{8}}+\frac{\overset{1}{\cancel{2}}\times\overset{1}{\cancel{4}}}{\underset{1}{\cancel{3}}\times\underset{1}{\cancel{3}}}\times\frac{\overset{1}{\cancel{5}}\times\overset{1}{\cancel{8}}}{\underset{2}{\cancel{8}}\times\underset{1}{5}\times\underset{1}{\cancel{2}}}$$

$$=\frac{7\times\overset{1}{\cancel{8}}}{\underset{1}{\cancel{8}}\times 61}+\frac{1}{3\times 2}$$

$$=\frac{7}{61}+\frac{1}{6}=\frac{42+61}{61\times 6}=\mathbf{\frac{103}{366}}$$

Example (4):—

$$\cfrac{7}{5+\cfrac{3}{1-\cfrac{1}{3-\frac{5}{7}}}}$$

This is what is called a **continued** fraction. It is easy to realise its meaning if we remember that the dividing line between numerator and denominator is a vinculum.

Thus

$$\cfrac{7}{5+\cfrac{3}{1-\cfrac{1}{3-\frac{5}{7}}}}=7\div\left\{5+\cfrac{3}{1-\cfrac{1}{3-\frac{5}{7}}}\right\}$$

$$=7\div\left\{5+3\div\left[1-\frac{1}{3-\frac{5}{7}}\right]\right\}$$

$$=7\div\left\{5+3\div\left[1-1\div\left(3-\frac{5}{7}\right)\right]\right\}$$

$$=7\div\left\{5+3\div\left[1-1\div 2\tfrac{2}{7}\right]\right\}$$

$$=7\div\left\{5+3\div\left[1-1\times\frac{7}{16}\right]\right\}$$

$$=7\div\left\{5+3\div\frac{9}{16}\right\}=7\div\left\{5+3\times\frac{16}{9}\right\}$$

$$=7\div\left\{5+\frac{16}{3}\right\}=7\div\frac{31}{3}=7\times\frac{3}{31}=\mathbf{\frac{21}{31}}.$$

But we work usually as follows:—

$$\cfrac{7}{5+\cfrac{3}{1-\cfrac{1}{3-\frac{5}{7}}}}=\cfrac{7}{5+\cfrac{3}{1-\frac{1}{\frac{16}{7}}}}=\cfrac{7}{5+\cfrac{3}{1-\frac{7}{16}}}$$

$$=\cfrac{7}{5+\frac{3}{\frac{9}{16}}}=\cfrac{7}{5+\frac{16}{3}}=\cfrac{7}{\frac{31}{3}}=\mathbf{\frac{21}{31}}.$$

Example (3):—

$$\left[2\tfrac{2}{3}+\frac{7}{10}\text{ of }3\tfrac{3}{4}-\left(3\tfrac{1}{2}-\frac{1}{6}\text{ of }12\right)\right]\div\left\{\left[\frac{4}{9}+\left(3-\frac{2}{3}\right)-\frac{1}{11}\text{ of }4\tfrac{5}{7}\right]+\frac{1}{12}\right\}$$

$$=\left[2\tfrac{2}{3}+\frac{\overset{1}{\cancel{7}}}{\underset{2}{\cancel{10}}}\times\frac{\overset{3}{\cancel{15}}}{\underset{1}{\cancel{4}}}-\left(3\tfrac{1}{2}-\frac{1}{\underset{1}{\cancel{6}}}\times\frac{\overset{2}{\cancel{12}}}{\underset{1}{\cancel{1}}}\right)\right]\div\left\{\left[\frac{4}{9}+2\tfrac{1}{3}-\frac{1}{\underset{1}{\cancel{11}}}\times\frac{\overset{3}{\cancel{33}}}{\underset{1}{\cancel{7}}}\right]+\frac{1}{12}\right\}$$

$$=\left[2\tfrac{2}{3}+\frac{21}{8}-\left(3\tfrac{1}{2}-2\right)\right]\div\left\{\left[\frac{4}{9}+2\tfrac{1}{3}-\frac{3}{7}\right]+\frac{1}{12}\right\}$$

$$=\left\{2\tfrac{2}{3}+2\tfrac{5}{8}-1\tfrac{1}{2}\right\}\div\left\{2\frac{28+21-27}{9\times 7}+\frac{1}{12}\right\}$$

$$=3\frac{16+15-12}{3\times 8}\div\left\{2\frac{22}{9\times 7}+\frac{1}{12}\right\}=3\frac{19}{3\times 8}\div 2\frac{88+21}{9\times 7\times 4}$$

$$=\frac{91}{3\times 8}\div 2\frac{109}{9\times 7\times 4}=\frac{91}{3\times 8}\div\frac{613}{9\times 7\times 4}$$

$$=\frac{91}{\underset{1}{\cancel{3}}\times\underset{2}{\cancel{8}}}\times\frac{\overset{3}{\cancel{9}}\times 7\times\overset{1}{\cancel{4}}}{613}=\frac{1911}{1226}=\mathbf{1\frac{685}{1226}}.$$

Example (5):—

$$\frac{3\frac{3}{4} + 2\frac{33}{4}}{5\frac{1}{2} \quad 2\frac{1}{5}} = \frac{3\frac{3}{8} + 2\frac{75}{44}}{7\frac{1}{15} - 1\frac{11}{20}}$$

$$7\frac{4}{5} - 1\frac{3}{4}$$

$$= \frac{5\frac{81}{44}}{6\frac{307}{660}} = \frac{301}{44} \times \frac{15}{667} = \frac{301}{11} \times \frac{60}{667} = \mathbf{\frac{4515}{7337}}.$$

Exercise 21

Simplify the following:

(1) $\dfrac{10\frac{2}{5} - 1\frac{5}{7}}{7\frac{1}{8} + 3\frac{3}{10}} + \frac{3}{7}$ of $2\frac{1}{17} \div \dfrac{1\frac{3}{5}}{2\frac{3}{7}}$

(2) $\dfrac{\frac{1}{21} \times 5\frac{17}{43} \times 6\frac{3}{11} + 6\frac{19}{31} \times 1\frac{35}{49} \div 2\frac{5}{17} + 11\frac{10}{42}}{0\frac{19}{57} \times 1\frac{22}{23} \div 5\frac{17}{38} + 3\frac{11}{18} \times 6\frac{17}{21} \div 7\frac{31}{52}} \times 12\frac{1}{9}$

(3) $$\cfrac{2}{7 + \cfrac{3}{5 + \cfrac{4}{6 - \cfrac{3}{1 - \frac{1}{9}}}}}.$$

(4) Twelve boys have a certain number of marbles. One of them has $\frac{1}{10}$ of the number, two of them have $\frac{1}{8}$ of the number each, three of them have $\frac{1}{20}$ of the number each. The rest of them have 80 among them, and five of these have each three times as many as the other boy. What was the whole number, and how many did each boy have?

(5) A man going on a journey, and travelling all the time at the same rate, finds that at 2 p.m. he has completed $\frac{3}{5}$ of his journey, and at 5 p.m. he has completed $\frac{9}{7}$ of his journey. When did he start and when did he arrive?

(6) If you deduct $\frac{7}{9} - \frac{2}{5}$ from a number, and to the difference add the quotient of $\frac{4}{15} \div 2\frac{2}{3}$, and multiply this sum by $\frac{3}{8}$ of $2\frac{1}{2}$, the result is $\frac{61}{192}$. What is the number?

67. Decimal Fractions are fractions which have 10 or a power of 10 as their denominator.

In our ordinary notation, *figures* in the *units* place have their *intrinsic* value, while for each place to the left of the units place the value of the figure increases *tenfold*.

If we look on the figures from the opposite point of view, i.e. going from left to right, instead of from right to left, we see that the value of a figure diminishes to *one tenth* of its former value for each place it is moved to the *right*.

Thus 6 has its intrinsic value, while in 60 the digit 6 indicates ten times its former value, and in 600 it indicates one hundred times its former value. Similarly, if we start with 600, then in 60 the digit indicates one tenth of its former value, and in it 6 indicates one hundredth of its former value.

This suggests a method of notation for decimals. Each figure to the right of the units place has one-tenth of the value it would have in the next place to the left of it.

We indicate the position of the units by a dot (placed a little above the line) immediately after the units place. This dot is called the **decimal point.** The places of figures to the right of this point are called **decimal places.**

Thus all the figures to the left of the decimal Point denote integers, while all figures to the right of the decimal point denote fractions with the denominators 10, 100, 1000, and so on.

Thus 374·6815 stands for

$$3 \times 100 + 7 \times 10 + 4 + \frac{6}{10} + \frac{8}{100} + \frac{1}{1000} + \frac{5}{10000}$$

It is usually *read*, three hundred and seventy four decimal six eight one five.

68. (*a*) Now consider ·1234.

$$\cdot 1234 = \frac{1}{10} + \frac{2}{100} + \frac{3}{1000} + \frac{4}{10000}.$$

The L.C.M. of the denominators is 10000. Hence reducing all the fractions to their lowest common denominator, we have:

$$\cdot 1234 = \frac{1 \times 1000}{10 \times 1000} + \frac{2 \times 100}{100 \times 100} + \frac{3 \times 10}{10 \times 1000} + \frac{4}{10000}$$

$$= \frac{1000 + 200 + 30 + 4}{10000} = \mathbf{\frac{1234}{10000}}.$$

(*b*) Next consider ·00451.

$$\cdot 00451 = \frac{0}{10} + \frac{0}{100} + \frac{4}{1000} + \frac{5}{10000} + \frac{1}{100000}.$$

(L.C.M. of denominators = 100000.)

$$\therefore \cdot 00451 = \frac{0 \times 10000}{10 \times 10000} + \frac{0 \times 1000}{100 \times 1000} + \frac{4 \times 100}{1000 \times 100} + \frac{5 \times 10}{10000 \times 10} + \frac{1}{100000}$$

$$= \frac{400 + 50 + 1}{100000} = \mathbf{\frac{451}{100000}}.$$

(*c*) Lastly consider 31·942.

$$31 \cdot 942 = 31 + \frac{9}{10} + \frac{4}{100} + \frac{2}{1000}.$$

(L.C.M. of denominators = 1000.)

$$\therefore 31 \cdot 942 = \frac{30 \times 1000}{1000} + \frac{1 \times 1000}{1000} + \frac{9 \times 100}{10 \times 100} + \frac{4 \times 10}{100 \times 10} + \frac{2}{1000}$$

$$= \frac{30000 + 1000 + 900 + 40 + 2}{1000} = \mathbf{\frac{31942}{1000}}.$$

We see by the above that **every decimal,** and every number made up of integers and decimals, may be expressed as a vulgar fraction by writing down the number as it is (omitting the decimal point) for the numerator, and placing in the denominator 1 followed by as many noughts as there are decimal places in the given number.

It is clear that zeros to the right of a decimal do not affect the value of the decimal any more than zeros to the left of an integer affect the value of the integer, for 0073 means no thousands, no hundreds, seven tens and three units (i.e. simply seven tens and three units), and similarly ·7300 means seven tenths, three hundredths, no thousandths and no ten thousandths (i.e. simply seven tenths and three hundredths).

69. Any vulgar fraction having 10 or a multiple of 10 as a denominator, can be expressed as a decimal.

Thus $\frac{3647}{100} = \frac{3 \times 1000 + 6 \times 100 + 4 \times 10 + 7}{100}$

$= \frac{3 \times 1000}{100} + \frac{6 \times 100}{100} + \frac{4 \times 10}{100} + \frac{7}{100}$

$= 30 + 6 + \frac{4}{10} + \frac{7}{100} =$ **36·47**

according to the notation used above.

70. It also appears that,

$\cdot 351 = \frac{351}{1000}$, $\cdot 0351 = \frac{351}{10000}$, $\cdot 00351 = \frac{351}{100000}$.

Hence ·351, ·0351, ·00351 are equivalent to three vulgar fractions, each with the same numerator, but the denominator of the second is ten times as great as that of the first, and the denominator of the third is ten times as great as that of the second.

Now $\frac{351}{10000} = \frac{351}{100000} \times 10$

$\therefore \cdot 0351 = \cdot 00351 \times 10$

and again $\frac{351}{1000} = \frac{351}{100000} \times 100$

$\therefore \cdot 351 = \cdot 00351 \times 100$

and further $\frac{351}{100} = \frac{351}{100000} \times 1000$

$\therefore 3{\cdot}51 = \cdot 00351 \times 1000.$

Thus we see that to multiply a decimal by 10, we move the decimal point one place to the right; to multiply by 100 we move the decimal point two places to the right; to multiply by 1000 we move it three places to the right and so on.

Similarly $\frac{351}{10000} = \frac{351}{1000} \div 10$

$\therefore \cdot 0351 = \cdot 351 \div 10$

and $\frac{351}{10000} = \frac{351}{100} \div 100$

$\therefore \cdot 0351 = 3{\cdot}51 \div 100.$

Hence we see that to divide a decimal by 10 we move the decimal point one place to the left; to divide by 100 we move the decimal point two places to the left and so on.

Exercise 22

Convert into vulgar fractions:

(1) ·7, ·07, ·71, ·713, ·00713, ·0007133.

Convert into vulgar fractions in their lowest terms:

(2) ·5, ·25, ·75, ·125, ·35, ·4, ·04, ·0025, ·256, ·0256, ·0008125.

Express as vulgar fractions in their lowest terms:

(3) ·075, 7·5, 1·728, ·01728, 172·8, ·010001, ·050005, ·0000002, ·0000001.

Express as decimals:

(4) $\frac{5}{10}$, $\frac{35}{100}$, $\frac{35}{1000}$, $\frac{1}{1000}$, $\frac{17}{100}$, $\frac{20}{1000000}$.

Multiply the following separately by 10, then by 100, and then by 1000.

(5) ·3, ·03, ·1765, 31·25, ·00312.

Divide the following separately by 10, then by 100, and then by 1000.

(6) ·3, ·03, ·0001, 397·8, 54·31, 765·2, 81. M. A. L.

ALGEBRA.—VII

54. The factors of many expressions can be found by rearrangement.

Thus $a^2x^2 - b^2y^2 + ax + by = (ax + by)(ax - by)$
$+ ax + by = (ax + by)\{(ax - by) + 1\}$
$= (ax + by)(ax - by + 1).$

No general rules can be given for rearrangement, but we shall work a few typical examples.

I. **When a letter occurs only in the first power,** the factors often become obvious by arranging the expression so that the coefficients of that letter are all grouped in one bracket.

Examples:—

(1) Find the factors of $ab^2 + b - a + 1$.
$ab^2 + b - a + 1 = a(b^2 - 1) + b + 1 =$
$a(b - 1)(b + 1) + (b + 1)$
$= (b + 1)\{a(b - 1) + 1\} = (b + 1)(ab - a + 1).$

(2) Factorise $y^2 + (a + b + c)y + ab + ac$.
$y^2 + (a + b + c)y + ab + ac$
$= a(y + b + c) + y^2 + by + cy$
$= a(y + b + c) + y(y + b + c) = (y + b + c)(a + y).$

II. **When the expression is quadratic with respect to one letter,** factors which are rational and integral **with respect to that letter** can be found as in § 52.

Examples:—

(1) Find the factors of $a^2 - 2b^2 - c^2 - ab + 3bc$.
Arranging according to powers of a, we have $a^2 - 2b^2 - c^2 - ab + 3bc = a^2 - ab - 2b^2 + 3bc - c^2$

$= a^2 - ab + \frac{b^2}{4} - \frac{b^2}{4} - 2b^2 + 3bc - c^2$

$= \left(a - \frac{b}{2}\right)^2 - \frac{b^2 + 8b^2 - 12bc + 4c^2}{4}$

$= \left(a - \frac{b}{2}\right)^2 - \frac{9b^2 - 12bc + 4c^2}{4}$

$= \left(a - \frac{b}{2}\right)^2 - \left(\frac{3b - 2c}{2}\right)^2$

$= \left(a - \frac{b}{2} + \frac{3b - 2c}{2}\right)\left(a - \frac{b}{2} - \frac{3b - 2c}{2}\right)$

$= (a + b - c)(a - 2b + c).$

(2) Find the factors of $1 + (b - a^2)x^2 - abx^3$, arranging in powers of x.

$1 + (b - a^2)x^2 - abx^3 = -a^2x^2 - abx^3 + bx^2 + 1$

$= -x^2\left\{a^2 + abx - \frac{bx^2 + 1}{x^2}\right\}$

$= -x^2\left\{\left(a + \frac{bx}{2}\right)^2 - \frac{b^2x^2}{4} - \frac{bx^2 + 1}{x^2}\right\}$

$= -x^2\left\{\left(a + \frac{bx}{2}\right)^2 - \frac{b^2x^4 + 4bx^2 + 4}{4x^2}\right\}$

$= -x^2\left\{\left(a + \frac{bx}{2}\right)^2 - \left(\frac{bx^2 + 2}{2x}\right)^2\right\}$

$= -x^2\left(a + \frac{bx}{2} + \frac{bx^2 + 2}{2x}\right)\left(a + \frac{bx}{2} - \frac{bx^2 + 2}{2x}\right)$

$= -x^2\left(a + \frac{2bx^2 + 2}{2x}\right)\left(a - \frac{2}{2x}\right)$

$= x\left(a + \frac{bx^2 + 1}{x}\right)(-x)\left(a - \frac{1}{x}\right)$

$= (ax + bx^2 + 1)(1 - ax).$

III. **When an expression contains only two powers of a letter,** and one is the square of the other, we can also use the method of §52.

Examples:—

(1) Find the factors of $x^6 - 6x^3 - 7$.

$x^6 - 6x^3 - 7 = (x^6 - 6x^3 + 9) - (9 + 7)$
$= (x^3 - 3)^2 - (4)^2 = (x^3 - 3 - 4)(x^3 - 3 + 4)$
$= (x^3 - 7)(x^3 + 1)$
$= (x^3 - 7)(x^2 - x + 1)(x + 1)$.

(2) Find the factors of $x^4 + x^2y^2 + y^4$.

$x^4 + x^2y^2 + y^4 = x^4 + 2x^2y^2 + y^4 - x^2y^2$
$= (x^2 + y^2)^2 - (xy)^2$
$= (x^2 + y^2 + xy)(x^2 + y^2 - xy)$
$= (x^2 + xy + y^2)(x^2 - xy + y^2)$.

(3) Find the factors of $x^4 - 23x^2 + 1$.

$x^4 - 23x^2 + 1 = x^4 + 2x^2 + 1 - 2x^2 - 23x^2$
$= (x^2 + 1)^2 - (5x)^2$
$= (x^2 + 5x + 1)(x^2 - 5x + 1)$.

(4) Find the factors of $x^4 - 7x^2y^2 + y^4$.

$x^4 - 7x^2y^2 + y^4 = x^2 + 2x^2y^2 + y^2 - 9x^2y^2$
$= (x^2 + y^2)^2 - (3xy)^2$
$= (x^2 + y^2 + 3xy)(x^2 + y^2 - 3xy)$
$= (x^2 + 3xy + y^2)(x^2 - 3xy + y^2)$

IV. **When an expression is of the form** $aX^2 + bX + c$, where X is any algebraic expression involving x we can again apply the method of §52.

Examples:—

(1) Find the factors of $(x^2 - x)^2 + 4(x^2 - x) - 21$.

Let $X = (x^2 - x)$ then the expression becomes
$X^2 + 4X - 21 = X^2 + 4X + 4 - (4 + 21)$
$= (X + 2)^2 - (5)^2$
$= (X + 2 + 5)(X + 2 - 5)$
$= (X + 7)(X - 3)$
substituting $x^2 - x$ for $X = (x^2 - x + 7)(x^2 - x - 3)$.

(2) Find the factors of $(x^2 + 4x + 8)^2 + 3x(x^2 + 4x + 8) + 2x^2$.

Let $x^2 + 4x + 8 = X$ then the expression becomes $X^2 + 3xX + 2x^2 = (X + 2x)(X + x)$ by inspection; substituting for X
$= (x^2 + 4x + 8 + 2x)(x^2 + 4x + 8 + x)$
$= (x^2 + 6x + 8)(x^2 + 5x + 8)$
$= (x + 2)(x + 4)(x^2 + 5x + 8)$ by inspection.

(3) Find the factors of $x^4 + 4x^3 + 8x^2 + 8x + 4$.

$x^4 + 4x^3 + 8x^2 + 8x + 4$
$= (x^2 + 2x)^2 + 4(x^2 + 2x) + 4$
If $x^2 + 2x = X$, substituting for X
$= X^2 + 4X + 4$
$= (X + 2)^2$ by inspection
$= (x^2 + 2x + 2)^2$.

(4) Find the factors of $(x + 1)(x + 3)(x + 5)(x + 7) + 15$.

$(x + 1)(x + 3)(x + 5)(x + 7) + 15 = x^4 + 16x^3 + 86x^2 + 176x + 120$
$= (x^2 + 8x)^2 + 22(x^2 + 8x) + 120$
if $x^2 + 8x = X$ substituting for X
$= X^2 + 22X + 120 = (X + 10)(X + 12)$ by inspection
$= (x^2 + 8x + 10)(x^2 + 8x + 12)$
$= (x^2 + 8x + 10)(x + 6)(x + 2)$ by inspection.

Exercise 9

Find the factors of—

(1) $a^2 - b^2 - c^2 + d^2 + 2(bc - ad)$. (2) $(2x + y - 1)^2 + 4(2x + y)$. (3) $x^2 - 2px + (p^2 - q^2)$. (4) $x^2 + (a + b)x + ab$. (5) $x^6 - (a - b)x^3 - ab$. (6) $x^8 - y^8$. (7) $3x^3 - x^6 - x^3 - 1$. (8) $27x^3 - 27x^2 + 9x - 1$. (9) $x^4 + 9x^2 + 81$. (10) $a^4 + a^3b - ab^3 - b^4$. (11) $x^8 + x^4 + 1$. (12) $x^2 - y^2 - 3z^2 - 2xz + 4yz$. (13) $x^4 - 14x^2y^2 + y^4$. (14) $x^3 + bx^2 + ax + ab$. (15) $4(x + 5)(x + 6)(x + 10)(x + 12) - 3x^2$. (16) $x^3 + px^2 + px + p - 1$. (17) $x^4 - 1 - 4(x - 1)$. (18) $xyz(x^3 + y^3 + z^3) - y^3z^3 - z^3x^3 - x^3y^3$. (19) $(x - 1)(x - 2)^2 - (x - 1)^3$. (20) $(x - 3)(x + 1)^3 + (x - 3)(x + 2)^3$. (21) $1 + ax - x^2 - ax^3$. (22) $8x^3 + 4(a - b + c)x^2 + 2(-bc + ca - ab)x - abc$.

55. Before proceeding with factorisation we must now go back and consider certain further aspects of division.

We have already shown that one integral function of x, say A, is not always exactly divisible by another function of x, say B, but that in addition to the quotient Q there may be a remainder R.

In this case we have $\frac{A}{B} = Q + \frac{R}{B}$.

It is clear that when A is of a lower degree in x than B that Q = O and the quotient becomes $\frac{R}{B}$ where R = A.

Thus $\frac{x^2 + 1}{x^3 + 1}$ cannot be transformed into an integral quotient, but remains fractional.

Now consider $\frac{x^2 + 1}{x + 1}$

$x^2 + 1 \equiv x(x + 1) - (x + 1) + 2$

$\therefore \frac{x^2 + 1}{x + 1} \equiv \frac{x(x + 1)}{x + 1} - \frac{x + 1}{x + 1} + \frac{2}{x + 1} \equiv x - 1 + \frac{2}{x + 1}$.

Now $\frac{2}{x + 1}$ is essentially fractional, since the degree of the numerator is less than that of the denominator

$\therefore$ the quotient $\frac{x^2 + 1}{x + 1}$ cannot be integral. For if it were possible to express this quotient as an integral function of x, say $px + q$,

then $\frac{x^2 + 1}{x + 1} \equiv px + q \equiv x - 1 + \frac{2}{x + 1}$

and hence, subtracting $(x - 1)$ from each side of the identity, we should have

$$(px + q) - (x - 1) \equiv \frac{2}{x + 1}.$$

That is an integral function identical with an essentially fractional function, which is impossible.

56. Now let us consider the conditions under which one integral function of x is exactly divisible by another integral function of x.

As before, let A be the dividend and B be the divisor.

If the degree in x of A be lower than that of B, then A cannot be exactly divided by B unless A be identically equal to O, i.e. if every coefficient of x in A and the absolute term (the term which does not involve x) vanish.

If the degree of A be not less than that of B, then we can express $\frac{A}{B}$ as $Q + \frac{R}{B}$ where R is of a lower degree in x than B.

i.e. $\frac{A}{B} = Q + \frac{R}{B}$

and $\therefore$ (subtracting Q from each)

$$\frac{A}{B} - Q = \frac{R}{B}$$

Now if $\frac{A}{B}$ be integral, then $\frac{A}{B} - Q$ must be integral, and hence $\frac{R}{B}$ must be integral. But the degree of R is less than that of B, and $\therefore \frac{R}{B}$ cannot be integral unless $R \equiv O$.

Hence we conclude that if $R \equiv O$, $\frac{A}{B} - Q$ is integral, and $\therefore \frac{A}{B}$ is integral, i.e. A is exactly divisible by B.

Thus the necessary and sufficient condition that one integral function of x should be exactly divisible by another integral function of x is that the remainder of the former, when divided by the latter, should vanish identically.

Examples:—

(1) $\dfrac{x^4 - x^3 - x + 1}{x^2 + x + 1}$

$$\begin{array}{r|l} x^2 + x + 1 & x^4 - x^3 - x + 1 \,(x^2 - 2x + 1 \\ & \underline{x^4 + x^3 + x^2} \\ & \quad -2x^3 - x^2 - x + 1 \\ & \quad \underline{-2x^3 - 2x^2 - 2x} \\ & \qquad x^2 + x + 1 \\ & \qquad \underline{x^2 + x + 1} \\ & \qquad 0 + 0 + 0 \end{array}$$

The remainder vanishes identically, and we have that the quotient of $\frac{x^4 - x^3 - x + 1}{x^2 + x + 1}$ is the integral function $x^2 - 2x + 1$,

i.e $x^4 - x^3 - x + 1$ is exactly divisible by $x^2 + x + 1$.

(2) Find the remainder when $x^9 - 2x^8 + 2x^6 - x^5 - x^3 + x^2 + 3x - 4$ is divided by $x^2 - 2x + 1$.

Let us put $x^2 - 2x + 1 = B$

and $x^9 - 2x^8 + 2x^6 - x^5 - x^3 + x^2 + 3x - 4 = A$.

then $A = Bx^7 - Bx^5 - Bx - B \cdot + 2x - 3$.

$$\therefore \frac{A}{B} = \frac{B(x^7 - x^5 - x - 1) + 2x - 3}{B}$$

$$= x^7 - x^5 - x - 1 + \frac{2x - 3}{B}.$$

Hence the remainder $= \frac{2x - 3}{B} = \frac{2x}{x^2 - 2x + 1}$.

If we are dealing with functions of two or more variables, we shall find that the quotient and remainder assume different forms with respect to each of the variables.

(3) Find the quotient and remainder when $x^3 + px^2y + qxy^2 + 6y^3$ is divided by $x^2 - 5xy + 2y^2$ taking first x and then y as a variable. And in each case determine numerical values for p and q so that the quotient may be integral. Taking x as variable,

$$x^2 - 5xy + 2y^2)x^3 + px^2y + qxy^2 + 6y^3(x + (p+5)y$$

$$\underline{x^3 - 5x^2y + 2xy^2}$$

$$(p+5)x^2y + (q-2)xy^2 + 6y^3$$

$$\underline{(p+5)x^2y - 5(p+5)xy^2 + 2(p+5)y^3}$$

$$\{(q-2) + 5(p+5)\}xy^2 + \{6 - 2(p+5)\}y^3.$$

Hence $\dfrac{x^3 + px^2y + qxy^2 + 6y^3}{x^2 - 5xy + 2y^2} = x + (p+5)y$

$$+ \frac{\{(q-2) + 5(p+5)\}xy^2 + \{6 - 2(p+5)\}y^3}{x^2 - 5xy + 2y^2}$$

In order that the quotient may be integral, the remainder must vanish identically; that is,

$$q - 2 + 5(p+5) = 0, \quad 6 - 2(p+5) = 0.$$

From the second of these we get $6 - 2p - 10 = 0$

$$\therefore -2p - 4 = 0 \therefore -2p = 4 \therefore p = -2.$$

Hence the second becomes $q - 2 + 5(-2 + 5) = 0$

$$\therefore q - 2 + 15 = 0 \therefore q + 13 = 0 \therefore q = -13.$$

Taking y as a variable,

$$2y^2 - 5xy + x^2)6y^3 + qxy^2 + px^2y + x^3(3y + \frac{(q+15)}{2}x$$

$$\underline{6y^3 - 15xy^2 + 3x^2y}$$

$$(q+15)xy^2 + (p-3)x^2y + x^3$$

$$\underline{(q+15)xy^2 - \frac{5(q+15)}{2}x^2y + \frac{q+15}{2}x^3}$$

$$\left\{(p-3) + \frac{5(q+15)}{2}\right\}x^2y + \left(1 - \frac{q+15}{2}\right)x^3$$

Hence $\dfrac{6y^3 + qxy^2 + px^2y + x^3}{2xy^2 - 5xy + x^2} = 3y + \frac{q+15}{2}x$

$$+ \frac{\left\{(p-3) + \frac{5(q+15)}{2}\right\}x^2y + \left(1 - \frac{q+15}{2}\right)x^3}{2y^2 - 5xy + x^2}$$

In order that the quotient may vanish, the remainder must vanish identically; that is,

$$p - 3 + \frac{5(q+15)}{2} = 0, \quad 1 - \frac{q+15}{2} = 0.$$

From the second $q = -13$, and hence from the first, $p = -2$.

As might have been expected, the conditions that the quotient should be integral are the same in each case, and from that point of view it is immaterial whether we take x or y as variable.

Key to Exercise 7

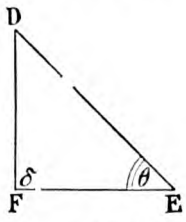
(1) $x + 2$. (2) $5x + 1$. (3) $3 + 3a + a^2$. (4) $a + 3b$. (5) $9x^2 - 6xy + 4y^2$. (6) $1 + 2x + 3x^2 + 4x^3 + 5x^4$. (7) $a^2 - a(2b - c) + (b^2 - bc + c^2)$. (8) $cx^2 + dx - c$. (9) $a^2 - ab + b^2$, $(a+b)^2 - (a+b)c + c^2$. (10) $x^2 + xy + y^2$, (i) $(x-y)^2 + (x-y)z + z^2$, (ii) $(x+y)^2 + 3(x+y)z + 9z^2$.

M. A. L.

GEOMETRY.—VI

As the theorem No. (2), Exercise 4, p. 248, is very important, we will give a key to it:

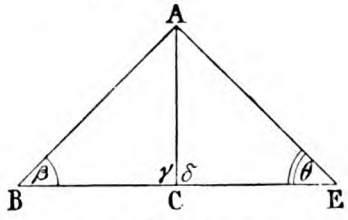
If two right-angled △s have their hypotenuses equal, and also one side of the one equal to one side of the other, they are equal in all respects.



Let A B C, D E F be 2 △s having
A B = D E
A C = D F
γ = 1 rt. ∠ = δ.

It is required to prove that △ A B C ≡ △ D E F.

Proof.—Place △ D E F so that D F falls on A C and the point D falls on A and the point E falls on the side of A C opposite to B.

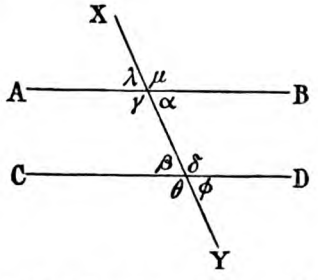


Then D F will coincide with A C ∵ D F = A C and γ = δ = 1 rt. ∠ ∴ B C E is a str. line (Prop. 2)
∴ A B E is a △.
Moreover A B E is isos. (∵ A B = A E, which is D E) ∴ β = θ (Prop. 6).
In △s A B C, D E F

γ = δ
β = θ
A B = D E

} ∴ △ A B C ≡ △ D E F (Prop. 9).

Definition.—Two straight lines in the same plane which never meet, however far they may be produced in either direction, are said to be **parallel.**



If the straight line X Y cuts two other straight lines A B, C D, it makes 4 angles α, γ, λ, μ, where it cuts A B and 4 angles β, δ, θ, φ where it cuts C D.

The angles α, γ, β, δ, which are between A B and C D are called **interior** angles.

The angles, λ μ, θ, φ, which are not between A B and C D, are called **exterior** angles.

The interior angle α and the interior angle β on the opposite side of X Y are called **alternate** angles.

The interior angle γ and the interior angle δ are also **alternate** angles.

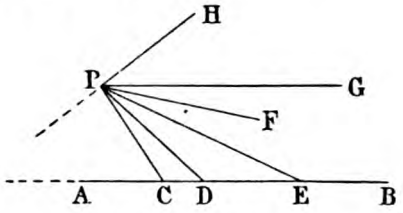
The exterior angle λ and the interior angle β on the same side of X Y are called **corresponding** angles.

Similarly γ and θ are **corresponding** angles
μ and δ are **corresponding** angles
α and φ are **corresponding** angles

Playfair's Axiom

Consider a straight line A B.

Draw a set of lines P C, P D, P E, P F, P G, P H through the pt. P.



In drawing P C the ruler is inclined rather steeply to A B, and in drawing P D, P E, etc., it is rotated round the pt. P so that its inclination to A B becomes less.

The pts. of intersection with A B move farther and farther from A.

P F does not meet A B, but if P F and A B were produced sufficiently far, they would intersect.

P G, which runs in the same direction as A B and is ‖ to it, will never meet A B however far they are both produced.

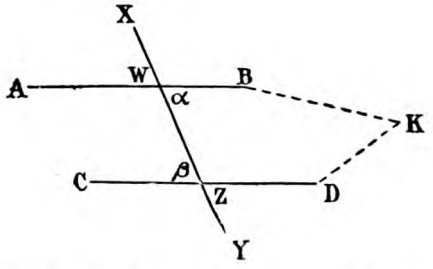
P H would meet A B if both were produced backwards, i.e. in the directions H P and B A.

We assume as obviously true that every line through P, except P G, meets A B if both be sufficiently produced. Thus we have the **axiom.**

Through one point there cannot be drawn more than one straight line parallel to a given straight line.

Proposition 23. Theorem

If a straight line cutting two other straight lines makes the alternate angles equal, then these two straight lines are parallel.



Let the str. line X Y (sometimes called a transverse line) cut the 2 str. lines A B, C D at W and Z, making α = alternate ∠ β.

It is required to prove that A B and C D are ‖.

Proof.—If A B be not ‖ to C D they must meet, if produced either in the direction of B and D, or in the direction of A and C.

Let them meet when produced in the direction of B and D at the pt. K.

Then W Z K is a △.

∴ ext. ∠ β > int. and opp. ∠ α.

but β = α by hypothesis

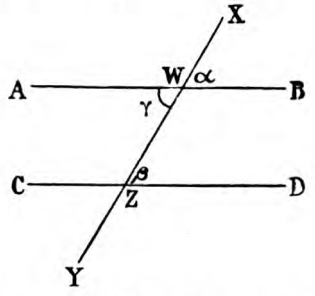
∴ this is impossible, and ∴ A B and C D do not meet when produced in the direction of B and D.

Similarly it may be shown that they do not meet when produced in the direction of A and C.

∴ A B is ‖ to C D.

Proposition 24. Theorem

If a straight line cutting two other straight lines makes the corresponding angles equal, then these two straight lines are parallel.



Let the transverse line X Y cut the 2 str. lines A B, C D at W and Z, making α = β.

It is required to prove that A B is ‖ to C D.

Proof.—α = vert. opp. ∠ γ (Prop. 3)

But α = β (hypothesis)

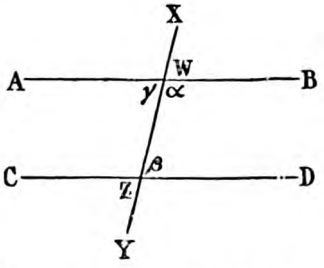
∴ γ = β.

But these are alternate ∠s

∴ A B is ‖ to C D (Prop. 23).

Proposition 25. Theorem

If a straight line cutting two other straight lines makes the sum of two interior angles on the same side equal to two right angles, then these two straight lines are parallel.



Let the transverse X Y cut the 2 str. lines A B, C D at W and Z, making α + β = 2 rt. ∠s.

It is required to prove that A B is ‖ to C D.

Proof.—α + γ = 2 rt. ∠s (Prop. 1).

But α + β = 2 rt. ∠s (by hypothesis)

∴ γ = β.

But these are alternate ∠s

∴ A B is ‖ to C D (Prop. 23).

Proposition 26. Theorem (Converse of 23, 24, and 25)

If a straight line cuts two parallel straight lines it makes (1) *the alternate angles equal,* (2) *the corresponding angles equal,* (3) *the sum of the interior angles on the same side equal to two right angles.*

Let the transverse X Y cut the ‖ str. lines A B, C D at W and Z.

It is required to prove that—

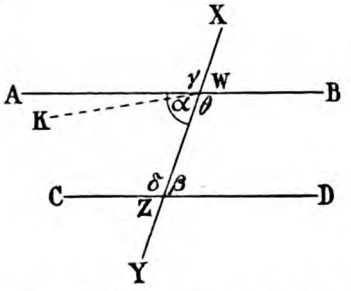
(1) α = β

(2) γ = δ

(3) α + δ = 2 rt. ∠s.

Proof.—(1) If α does not = β

At pt. W in the str. line Z W make ∠ Z W K = β (Prop. 18).



Now K W Z and β are alternate ∠s ∴ K W is ‖ to C D (Prop. 23), hence A B and K W which intersect at W both are ‖ to C D, which is not possible.

∴ α is not unequal to β, i.e. α = β.

(2) γ = vert. opp. ∠ θ (Prop. 3)

but θ = alternate ∠ δ (Prop. 26 (1))

∴ γ = δ.

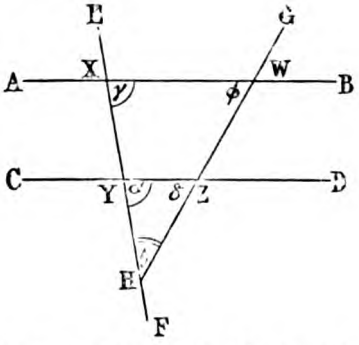
(3) δ + β = 2 rt. ∠s. (Prop. 1)

but β = α

∴ α + δ = 2 rt. ∠s.

Proposition 27. Theorem

Two straight lines which are parallel when tested by one transverse line are parallel when tested by any other transverse line.



Let A B and C D make equal ∠s γ and α on one side of the transverse line E F which cuts them at X and Y.

Then A B and C D are ‖ (Prop. 24).

It is required to prove that

(1) A B and C D are ‖ when tested by the transverse line G H which meets E F at H (*see* Fig. 1).

(2) A B and C D are ‖ when tested by the transverse line G H which does not meet E F (*see* Fig. 2).

Proof:

(1) $\gamma + \theta + \varphi = 2$ rt. $\angle$s ($\angle$s of a $\triangle$)

$\alpha + \theta + \delta = 2$ rt. $\angle$s ($\angle$s of a $\triangle$)

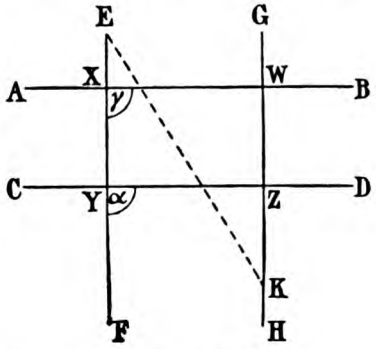
$\therefore \gamma + \theta + \varphi = \alpha + \theta + \delta$

$\therefore \gamma + \varphi = \alpha + \delta$

but $\gamma = \alpha$ (hypothesis)

$\therefore \varphi = \delta$

i.e. A B and C D are ‖ as tested by G H.



(2) Take any pt. K in G H below C D.

Take any pt. E in E F above A B.

Join E K.

Transverse line E K meets transverse line E F at E, then ∵ A B and C D are ‖ when tested by E F

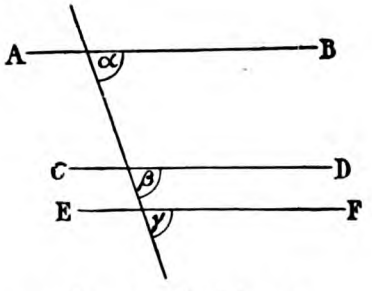
∴ A B and C D are ‖ when tested by E K (Part (1) of Prop.).

Transverse line G H meets transverse line E K at K, then ∵ A B and C D are ‖ when tested by E K

∴ A B and C D are ‖ when tested by G H (Part (1) of Prop.).

Proposition 28. Theorem

Straight lines which are parallel to the same straight line are parallel to one another



Let A B and C D each be ‖ to E F.

It is required to prove that—

A B is ‖ to C D.

Proof.—Let any transverse line make the corresponding $\angle$s α, β, γ with A B, C D, and E F.

A B is ‖ to E F $\therefore \gamma = \alpha$ (Prop. 26)

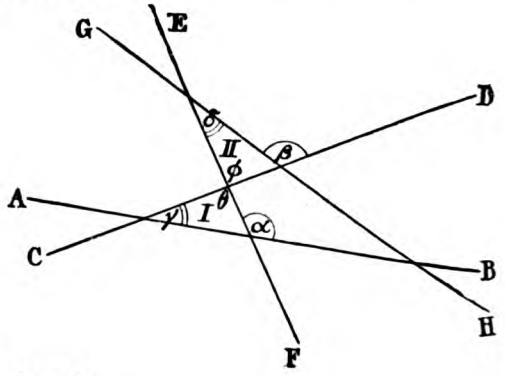
C D is ‖ to E F $\therefore \gamma = \beta$ (Prop. 26)

$\therefore \alpha = \beta$

$\therefore$ A B is ‖ to C D (Prop. 24).

Important Additional Theorem. A

If two straight lines E F and G H make equal angles α and β with two intersecting straight lines A B and C D on corresponding sides of them, then the $\angle$ γ between A B and C D equals the $\angle$ δ between E F and G H.



Proof:

α is ext. $\angle$ of $\triangle$ I. $\therefore \alpha = \gamma + \theta$ (Prop. 4, Cor. 3)

β is ext. $\angle$ of $\triangle$ II. $\therefore \beta = \delta + \varphi$ (Prop. 4, Cor. 3)

but $\alpha = \beta$ (hypothesis)

$\therefore \gamma + \theta = \delta + \varphi$

but θ = vert. opp. $\angle$ φ (Prop. 3)

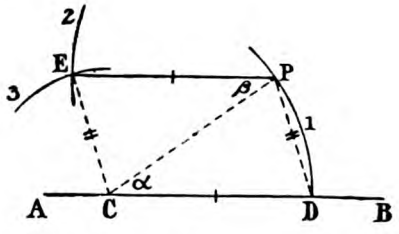
$\therefore \gamma = \delta$

NOTE.—The student should draw a figure for the case which is of frequent occurrence when α and β are rt. $\angle$s.

Proposition 29. Problem

Through a given point to draw a straight line parallel to a given straight line.

Let A B be the given straight line and P the given pt.



In A B take any pt. C.

With centre C and radius C P describe ⊙1 cutting A B at D.

With centre P and same radius describe ⊙2.

With centre C and radius = P D describe ⊙3 cutting ⊙2 at E.

Join P E.

Then P E is ‖ to A B.

Proof.—Join E C, C P and P D.

In △s D C P, E P C

C D = P E (radii of equal ○s)

P D = C E (radii of equal ○s)

C P is common

∴ △ D C P ≡ △ E P C

∴ $\alpha = \beta$

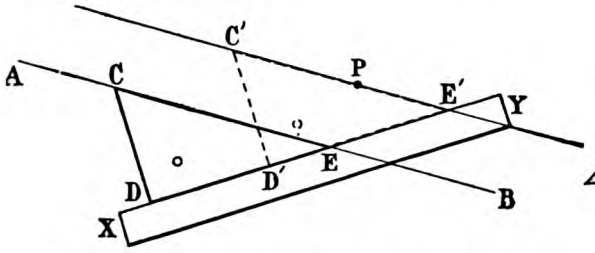
but these are alternate ∠s

∴ E P is ‖ to C D i.e. ‖ to A B (Prop. 23).

Alternative Method

Let A B be the given str. line and P the given pt.

Place a set square C D E with its long edge C E along the given line A B.



Against the edge D E of the set square place a flat ruler X Y.

Hold X Y firmly and slide the set square along the ruler until its edge C E passes through the pt. P. It will then be in the position C′ D′ E′.

Draw the line C′ P E′ along its edge.

Then C′ P E′ is ‖ to A B.

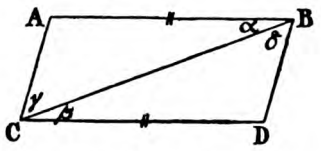
Proof.—∠ C′ E′ D′ is an ∠ of the set square and ∠ C E D is the same ∠ of the set square

∴ ∠C E D = corresponding ∠ C′ E′ D′

∴ C′ P E′ is ‖ to C E, i.e. to A B (Prop. 24)

Proposition 30. Theorem

The straight lines which join the corresponding extremities of equal and parallel straight lines, are themselves equal and parallel.



Let A B, C D be two equal and ‖ str. lines.

It is required to prove that A C = B D and A C is ‖ to B D.

Proof.—Join B C.

∵ B C cuts the ‖ str. lines A B, C D

∴ α = alt. ∠ β (Prop. 26).

In △s A B C, D C B

A B = D C (hypothesis)

B C is common

included ∠ α = included ∠ β

∴ △ A B C ≡ △ D C B (Prop. 5)

∴ A C = D B

and $\gamma = \delta$.

But γ and δ are alternate ∠s made by B C cutting A C and B D

∴ A C is ‖ to B D (Prop. 23).

Definitions.—A *parallelogram* is a four-sided figure which has its opposite sides parallel. (Figs. *a*, *b*, *c*, or *d*.)

A *rectangle* is a parallelogram which has one angle a right angle. (Figs. *a* or *b*.)

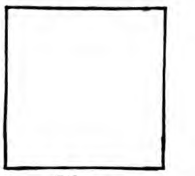


Fig. *a*.

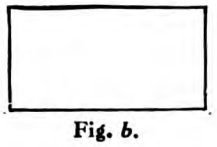


Fig. *b*.

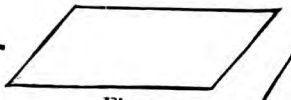


Fig. *c*.

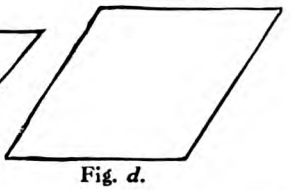


Fig. *d*.

A *square* is a quadrilateral having four equal sides and one angle a right angle. (Fig. *a*.)

A *rhombus* is a quadrilateral having four equal sides, but no angle a right angle. (Fig. *d*.)

Exercise 8

1. The perpendicular distances of a point P from two parallel straight lines are equal. Through P any straight line passes, cutting the parallel straight lines in A and B respectively. Show that A B is bisected in P.

2. Two sides of a quadrilateral are parallel and unequal. Prove that the other sides will intersect when produced.

3. If A B, C D be a pair of intersecting straight lines, E F a line parallel to A B, and G H a line parallel to C D, prove that the angle α between A B, C D equals the corresponding angle β between E F and G H.

4. Within triangle A B C, straight lines A D, B E C F are drawn making with A B, B C, C A respectively, the angles D A B, E B C, F C A equal to each other; show that if A D, B E, C F do not meet in a point they form a triangle whose angles are equal to those of triangle A B C.

5. If two circles intersect, prove that the line joining their centres is perpendicular to the line joining their points of intersection.

6. Draw a triangle A B C with A B, B C, C A respectively 6, 9, and 12 cm. long. Through B draw a line B D parallel to A C and lying in the same direction, and make B D 6 cm. in length. Join A D, and prove that it bisects the angle B A C. If B D′ were drawn of the same length as B D, but in the OPPOSITE direction, prove that A D′ would bisect the exterior angle between A B and A C. (London Matric. Exam.)

7. Through the angular points A, B, C of an equilateral triangle are drawn three straight lines respectively perpendicular to C A, A B, B C. Show that the triangle formed by these three straight lines is also equilateral. (London Matric. Exam.)

M. A. L.

Continued from page 304.

ART AND MUSIC:

Contributors **:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).**

JOY OF THE ARTIST'S LIFE

WHAT is the main difference between the lives of artists and those of the majority of their fellows? We are talking now of people who earn their own living, and by artists we mean those who earn a livelihood from any one of the arts—painting or poetry, the writing of fiction or the composing of operatic music.

There are, naturally, ten thousand differences, but is there not some one underlying and essential difference which includes the rest? Some say that it lies in the taint of money. So many callings mean the direct handling of gold. You add two and two together, make it four, and then stretch out a hand and grab your reward. You add two and two together and make it five, and people say, "He's a financial genius."

Self-expression

But this only shows the difference between art and business. There is a wider difference than that. It comes to this: Art is a man's life. He never stops being an artist. He lives for his work in a far stronger degree than he lives by it. If a man follows any other calling he is done with it when he has accomplished so many hours a day. The business man goes to his office, does his day's work, and after it is over begins to live. By this it is not meant that he does not often enjoy his work or that he does not think about it after office hours. But he does have to go outside his work to find the materials of a happy life. The artist does not. That is the chief difference between the two.

The artist is always an artist. His whole outlook on life, as well as his physical outlook from his bedroom window, is peculiar to himself. He lives to create things of beauty, and his reward is that he can see things of beauty all around him.

This is more particularly the faculty of the painter. The majority of men who are not artists see a gasometer, some scaffolding, a steam crane, and a rock of smoke above a grimy town, and they take no notice: or else, being of the conveniently romantic sort, they say, "What a pity. All that dirt and filth, and those ugly appliances spoiling what was once a lovely landscape."

The artist, with trained eyes or with eyes which see instinctively, knows a different version of that story. The gasometer's great looming bulk rises, dimly defined, against a horizon of wistful grey.

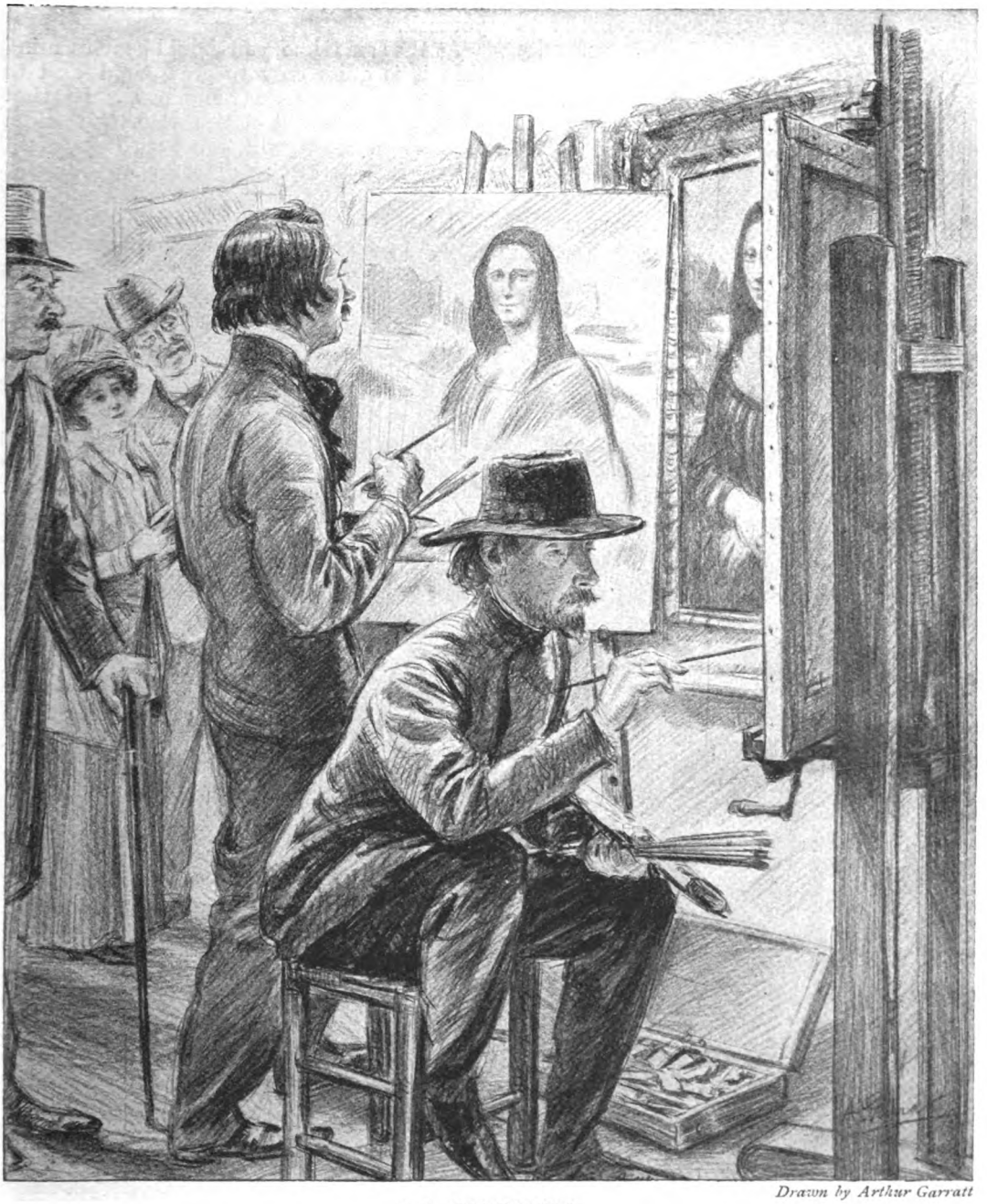
Beauty in Ugliness

The steam crane raises a purple arm above the vague yet complex arrangement of timbers; all kinds of unsuspected and surprising colours jump to the artist's vision from the smoke cloud above a city of violet and darkling green.

The artist thinks how the murky river may be translated with all its subtle light and glimpses of colour on to canvas. Other people think, "Well—it's a dirty old ditch, but with a lock here and a bridge there—something can be made out of it." That something, need I insist?—is money.

The artist's life is above all others free and unrestrained. He has no hours to keep. He works as it pleases him with only the light to consider. He must work very hard to keep the wolf from the door, but then he wants to work hard. He is working for himself, expressing himself in terms of colour or of rhythm or of sound. He has no anxiety about catching the 8.50 in the morning. He is divinely free. He is a great deal out of doors. The troublous affairs of the outside world do not hamper his activities. It is a healthy, jolly life.

He is perpetually searching for what is true and what is lovely. And chiefly is he happy because his study of physical proportion in his art leads him to a vantage point whither he can see life as a whole in



Drawn by Arthur Garratt

LA GIOCONDA.

The masterpiece of Leonardo da Vinci (1452–1479), best known to the British public as the *Mona Lisa*, was stolen in 1911 from the Louvre in most mysterious circumstances but fortunately has since been recovered. It has been copied by Paris art students to a greater extent probably than any other picture. At one time so many copies had accumulated in the cellars of the Louvre that the French Finance Minister introduced a Bill to empower him to sell them for the benefit of the State Above is shown what in the old days was a familiar scene in the Louvre.

perhaps a truer proportion than others. The things which matter so enormously to the crowd leave him either laughing or quite cold. His quick rages and fiery indignations are, on the other hand, perfectly incomprehensible to the generality. He is far more prone to mind his own business than are others. His outlook is more childish and therefore in all ways better than the outlook of the uncreative worker.

J. G. B. L.

DRAWING.—V

Drawing, whether in the advanced stages where you are giving expression to your own ideas, or whether you are still learning the rudiments of technique, should never be allowed to become a grievous labour. By this is not meant that you should avoid being laborious; on the contrary, success in any marked degree is only to be attained by the greatest care, hard work and trouble. But there is a vast gulf of difference between hard work and work that is painful. Hard work is absolutely essential to good results—really hard work. But you should never grow over-tired through it, and you must also learn not to be cast down by temporary discouragements. The great thing is to work systematically, to learn *how* to work.

Draw and study until you are tired by all means, but not beyond that point. If you do go beyond it your work will suffer. If this rule is to be followed out properly, you must learn the difference (which is considerable) between genuine fatigue and sheer discouragement. You may have been trying to copy something or other for an hour, at the end of which time you find you have not gone forward at all. As soon as you have mastered one difficulty, another has taken its place. You have learned to conquer one sort of mistake, only to discover that two or three others still remain to be corrected.

How to Work

This is not being tired. You want to stop, of course, and tear up your paper; but the condition is that of discontent merely. It is bound to come if you take any real interest in your work, and your work will never advance far unless you are discontented with it periodically. If, especially in early days, you make a drawing which completely satisfies you, you are either a very wonderful person indeed, or else you may as well give up at once and take to something else. You will never make any progress worth speaking of if you are satisfied with yourself.

At the same time, you should bear in mind that it is quite easy to grow tired and to spoil your best endeavours owing to that fact; and you will notice that the same amount of work will affect two different people in two totally different ways. One will be worn out at the end of it, and one will remain quite fresh. And this disparity is out of all proportion to their respective capacities. The reason for this is, that one knows how to work and the other does not.

As shown at the beginning, the position you take up has a great deal to do with it. Do not fall into the easy error of believing that the first natural position you find yourself in for drawing must necessarily be the best position. That is how the mistake so often arises. Art is not natural, therefore the position you take up for the practice of art cannot be natural. At least it is not natural in the sense that you can flop down into any sort of posture that appears for the moment to be most comfortable. You must *learn* the right position to sit in at work.

Some Useful Suggestions

It has been said before that you should be in an upright position with your drawing-board sloping directly before you, and that the object you are copying should be immediately behind that. You should be able to throw your eye from the object to your paper with the minimum of exertion. If the object is itself a copy, you should arrange it by propping it up on the table in front of you at just a little distance behind your drawing-board. If you have an easel or a portable reading-desk these can be usefully employed.

The drawing-board should be propped up with a thick book so as to obtain a convenient slant. It is just as well to remember that one thick book will be found just twice as serviceable as two thin ones, which put together give the same amount of height. Two books are far more likely to slip, and your drawing-board may so become unsteady and will cause you, perhaps, to make some mistake just as you are drawing a finished outline or performing some other task which might be entirely spoiled for the time being by some such small accident. Anyhow, that sort of thing is very trying to the patience, and can well be avoided.

As to your own position, be comfortable, but do not lounge. Do not, on the other hand, sit bolt upright in a stiff and awkward manner, but try to cultivate the habit of

being upright in an easy manner, so that your chest is not constricted, and so that all your movements are free. Try not to lean over your drawing-board. Have it in a central position immediately before you, so that your eye falls on the middle of the drawing. A most important point to remember is that your hand whilst drawing should not lie on your paper. The reason for this is two-fold.

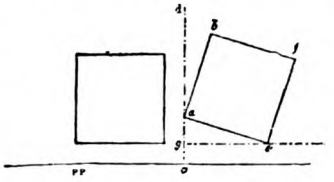


Fig. 21.—A problem in angular perspective.

First, if there is any pencil work beneath it, your hand will smear and rub it however hard a pencil you have used; and, secondly, even when you have not already drawn anything upon that part of the paper where your hand is resting, the warmth of your hand is apt to spoil the surface. Always keep a spare piece of paper for your hand to rest on. This piece of spare paper is useful also for rubbing down the point of a soft pencil when you want a broad point to shade with. Moreover, it often happens that your india-rubber gets dirty and covered with lead from much erasing. You can rub it on your spare paper and so get a clean surface to work with. If you are careless with your india-rubber, all you will succeed in doing will be in making an ugly smear across your paper, which may prove very difficult to remove, and may result in your labours being wasted.

Always keep your drawing-board and paper under cover for the same reason, out of the way of dust and smuts. Being flat, drawing materials take up very little room in a drawer, though perhaps it is better to keep a box separate for them.

Before finishing with the question of Perspective, which in truth could never be too exhaustively dealt with, we must turn for a while to Angular Perspective, which is quite as important as Parallel Perspective. Angular Perspective governs the drawing of any object the corner or angle of which comes nearest to the picture plane. When this happens, all the lines of the sides—whether the object be a house, a barn or a box—retire. All rectangular forms particularly fall under this rule.

Angular Perspective is a more difficult matter to master than parallel perspective, for the reason that there is an almost infinite variety of forms in which it may arise. If the lines of the object are parallel and perpendicular to the picture plane—that is, if the side lines of a rectangular object are perpendicular and the top and bottom lines parallel to a straight line drawn across your paper, or the bottom edge of your drawing board—then the subject is one for parallel perspective. But if, on the other hand, the lines are the least little bit out of the perpendicular or at variance with the parallel to the picture plane respectively, then it is a case for angular perspective.

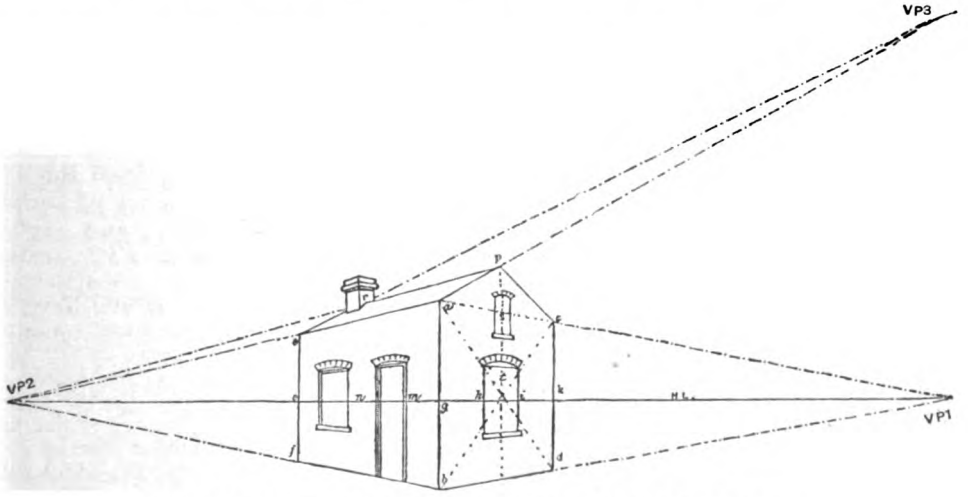


Fig. 22.—A valuable and interesting exercise in perspective.

Take Fig. 21, whose lines *a b* and *e f* are slanting away from the perpendicular line *g d*. Also the lines *a e* and *b f* slant from the line *g e* which in its turn is parallel to the picture plane. The angle at *e* represents the amount that the object is out of the parallel.

Now regard Fig. 21 as the ground plan of a house, Fig. 22, and you will see that the point *e* corresponds with the corner or angle facing or next to the picture plane in Fig. 22, which is *a b*. Now the end

of the house *a b c d* retires to the vanishing point 1. The side of the house retires to the vanishing point 2, which is on the left hand.

It is from the station point that you settle your vanishing points, looking directly at the angle of the house. The distance of the vanishing points from the P.S. is determined by your own distance from it, in the way that was explained before. The following rule for settling the question of vanishing points has been laid down—a rule which really comes under the heading of Geometrical Perspective:

Draw a line from the station point, parallel to the ground plan as far as the plane of the picture, from which draw a perpendicular line to the horizontal line, or line of sight. This will give the vanishing point.

The nearer the object the station point is, the nearer together come the vanishing points on either side.

Detecting Mistakes

A very useful exercise to practise is to take any drawing or engraving, of a building for instance, and to find out where the vanishing points are. You should, for this purpose, follow out and produce in your mind's eye all the retiring lines. There ought not to be the smallest difficulty about this, save perhaps where the lines in question or one of them is very short, with a very slight inclination indeed away from the parallel.

Take Fig. 22 again, and imagine for a moment that the lines have not been produced to the given vanishing points. The side of the house, top and bottom respectively, represented by the lines *a e* and *b f* meet at the V.P. number 2. The lines *a c* and *b d* forming the end of the house run out at V.P. number 1 on the right of the diagram. You can always find the vanishing points on any picture, etching or engraving in exactly the same way. The same method will be employed for finding the line of sight, which runs through the vanishing points of all horizontal retiring lines. If you find that horizontal retiring lines do not meet at the same place, you may be sure that this is because they are not parallel retiring lines, or, put in a different way, the very objects represented are not parallel with each other. However many parallel retiring lines there are, they will all have the same vanishing point, only—observe this carefully—they must be parallel. But if no two of any number of retiring lines you like to mention are parallel, then all these retiring lines will each have a different vanishing point.

Turn to your etching or engraving again and trace out in your imagination as many of the retiring lines as you can. The lines of bricks and stones are horizontal retiring lines parallel with each other and with the bottom of the wall and its top: so are the lines of the windows and doors. If you find that retiring lines which are obviously meant to be parallel do not meet at the same vanishing point, then you will know for certain that the picture before you is wrongly drawn, and you will have the undoubted pleasure of discovering a mistake made by someone else.

Once more, now return to Fig. 22, and draw it for yourself, observing this order:

Draw the horizontal line, or line of sight, and mark it H L. Put in the position of *g*, which is the nearest point to the eye, and most easily seen. Then mark *h i k* on the right hand with V.P. number 1. After that, working to the left from *g*, put in *m n o* with V.P. number 2. If there are any other lines crossing H L, put them in according to their exact position. Carefully determine the positions of *a* and *b*, and then draw the line *a g b*.

Now you come to the retiring lines, which must be marked with the greatest possible care. From *a* draw *a c* and *b d* to the first vanishing point, and then *a e* and *b f* to the second vanishing point. The line *e f* is drawn now through *o*, and *c d* through the point *k*. The doorway has already been determined, so far as its width is concerned, by two points *m n*, so there is no difficulty about those lines. The tops, both of the door and the window to the left of it, run exactly parallel with *a e* and have the same vanishing point—that is, number 2.

You now want to find how the line representing the apex or ridge of the roof goes. This is over the middle of the house. How are you to find that? You will observe that *a c* represents the width of the house, therefore a line drawn through the middle of *a c* will find the right point for the apex of the roof to start from. But as *a c* is a retiring line this measurement will not come out correctly in a drawing. How do you find the middle line of the end of the house when you take perspective into consideration? Join *a d* and *c b* by straight lines. These diagonal lines will give the middle at *t*. Now draw a perpendicular line through *t* from the bottom, and you find *s*, which gives the *perspective middle*, so to speak, on the line *a c*. Produce this line and you arrive at *p*. From *p* draw a line parallel to *a e* with V.P. 2, and you get *p r*, the ridge of the roof. Next join *a p*, which retiring line will run off to yet another V.P.—number 3. The line *e r* goes parallel with *a p*, and therefore to the same V.P.—number 3.

Imagination and Technique

Join *c p* and you have your roof. The rest of the drawing should give no trouble. The window at the end of the house is in the middle, which makes its position extremely easy to draw. Its width can be correctly determined by the diagonal lines *a d* and *c b*. The smaller window above it is bisected by the line *p s t*. The horizontal lines of the chimney are, firstly, on the left-hand side parallel with those of the roof, and, secondly, on the right-hand side parallel with the line *a c*, so that the vanishing points are number 2 and number 1 respectively.

Do not be content with practising this drawing once. Keep on until you have not the smallest hesitation about the right placing of a single line or a single point. It is a good exercise, if taken with *mental exercises* before some similar picture or etching as described. The one will help to train your eye and hand, the other will help to train your eye and mind for the proper study of Perspective. By the one method you will acquire technique. By the other method you will develop your imagination, without which technique would be valueless.

J. G. B. L.

Continued from page 384.

BUSINESS AND COMMERCE:

Contributors:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).

COMMERCIAL TRAINING.—VII

WHETHER the typist is using his own machine or is merely acting as the steward for his employer's typewriter, cleanliness is of the utmost importance to ensure efficient work. Every morning, in fact, certain parts should be dusted and cleaned and occasionally oiled.

The parts that will mostly require dusting are the cylinder, the paper feed, the gear upon which the carriage runs, and the keys. Oil will be required on the wheels and cogs upon which the carriage moves, upon the sliding movement which raises or lowers the carriage as the machine is set from small letters to capitals and numerals, and *vice versa*, and upon the bearings of the wheel that controls the tension. Only the best typewriter oil should be employed, only a minute drop should be used at a time, and any superfluous oil should be removed at once.

Typewriting Hints

As a matter of fact, the majority of typists use the oilcan too frequently, and it is easier to over-oil the delicate mechanism of a typewriter than one would imagine, for the oil collects dust, and dust works more mischief than anything else.

Writing of dust, every operator should make a particular point of covering his machine with its tightly fitting hood directly he ceases to use it, and no typewriter should be left uncovered, especially at night. Just occasionally, according to the amount of work done by the machine, the actual type will require cleaning, and for this purpose a kind of large toothbrush is supplied, the type being held in one hand and vigorously brushed with the other; it is a good plan also, in the case of such letters as o, e, g, p, and d, for example, to rout out the centre with the point of a pin carefully used.

Every typewriter possesses, as the motive power of the carriage, a powerful spring connected with the carriage by a length of gut or steel wire. As you depress a key the carriage is released one space on the scale and the tension spring pulls it along.

Now, it will be quite obvious that if this tension is weak the movement of the carriage will be slower than the actual typing, whilst if it is too strong there will be a tendency for the carriage to jump two places instead of one. The tension then must be regulated by means of the thumb-screw provided should there be occasion, but so long as the machine is running well the less the tension is touched the better.

Generally speaking, the typewriter is mostly employed in offices for the purposes of correspondence, and the self-taught student should practice again and again until he can type letters or address envelopes on the machine, not only neatly and accurately, but also in strict accordance with the most up-to-date principles.

A Model Letter

Let us, therefore, type a business letter together, discussing the various points and side-issues as we come to them. On the headed note-paper which we find in the stationery cabinet there is a ruled line left after the name of the city for the purposes of the date, thus:

BRISTOL,_____192____

We have to insert the words January 22nd and the final numeral 0, and it is obvious that the typing of these letters and numerals must fall almost exactly on the printed line. As the actual alignment varies slightly with all makes of typewriter, this point can only be gauged by personal experience and

experiment; but the scale must be used to ensure even spacing, so that whether we are writing May 1st or the much longer September 29th, they shall fall nicely as regards the key figures 192 . Whether we put 22nd March, March 22nd or write March the twenty-second must depend upon the rule of the office, a point with which every clerk should make himself conversant on the first day of his employment.

Each employer has his own idiosyncrasies in matters of this sort, and careful attention to them forms the stones with which the road to promotion in his service is paved.

Next, we have to put the style and address of the firm to which we are writing. If the letter is a long one, likely to fill the sheet of note-paper, we can use the single spacing, thus:

Messrs. Fry, Dawson & Co., Ltd.
(Country Department),
271, Cranford Lane,
Westminster,
LONDON, S.W.1.

Now, to write this letter, the marginal space stop on the second scale at the back of the machine should have been set at 10, at which point the D of "Dear Sirs" began. Note that a comma follows the "Sirs," and that the "re" (meaning "with reference to") starts with a small letter, and also that the r in "re" falls below the r in "Sirs." Note also that "Sirs" begins with a capital letter.

You will see that the line "re Garden Rollers" (i.e. the subject matter of the letter) is underscored. On all typewriters there are two stops or keys that make lines: the one used solely for underscoring as it comes below the alignment of the letters, and the other employed for hyphenation, thus: For underscoring _____; for hyphenation or long or short dashes: Hen-pecked, --, -------. As both these signs have, as it were, a cutting edge, they should be used but lightly, or the note-paper would be pierced.

However, to return to our letter. After "Rollers" there is a full stop, and we begin the next line with a Capital set three spaces beyond the "re." For the setting out of "16 x 16," meaning sixteen inches each way, we use the small letter x with one space before it and one after. Note the use of the shilling stroke, which comes among the figures on a typewriter, in "31/6." The next line: "We shall be glad," etc., begins on 20, as do all new paragraphs.

The actual closing of a letter depends upon the rule of the office. Some firms put "Yours truly," others "Yours faithfully," and so on. Others, "We remain, dear Sirs, Yours faithfully." It is impossible to lay down a rule. Every firm will be found to have its own methods of procedure, and the newcomer will be well advised if he makes himself familiar with it at the outset.

Note that the first line begins with a Capital, that there is a comma after remain, small d and Capital S, and a comma at the end of the line. The first line begins at 25 and the second 10 spaces later. When typing only "Yours faithfully," begin at 35 and note that the line ends with a comma; "Yours truly," being shorter, may start at 40. The Y is always a Capital, but the f or t, on the other hand, should never be a capital but always a small letter.

Now and again it may be necessary to employ Roman numerals in a letter, and when this occurs the letter I as a capital stands for 1. The numeral 1 against capital letters would naturally look out of place. These examples will explain the point: Wrong—1V, 1X. Right—IV, IX.

Dear Sirs,

re Garden Rollers.

We are in receipt of your letter and quotation of yesterday's date, and note that the 16 x 16 rollers, weight 2 cwt., come out at 31/6.

We shall be glad -------

A. B.

CHOOSING A CAREER.—VII

Emigration (*continued from p.* 380).—Of all Great Britain's overseas dependencies, the Dominion of New Zealand is most like the Old Country from the point of view of customs, occupations and the general routine of life. So far as climate is concerned, New Zealand enjoys weather not unlike our own, but rather warmer and more equable. There are no long periods of drought such as occur in Australia, and so far as climate could be that of New Zealand is ideal.

NEW ZEALAND is divided into two main islands, the North and the South. The latter is slightly the larger, the two together being a trifle less in area than Great Britain and Ireland. At no point can one be more than 75 miles from the sea, and there are mountains, rivers, streams and lakes which make the country one of the most beautiful in the world, whilst the opportunities for sport of every type are unequalled anywhere.

From the outlook of the emigrant, the openings in New Zealand are mainly those for the agriculturist, and farming here is conducted more on the concentrated lines of the Old Country than in any other colony. Mixed farming, which embraces the keeping of horses, cattle, sheep, pigs and poultry, and the growing of hay, corn, root crops and fruit, is most common, and the individual flocks of sheep are much smaller than is the case in the Australian Commonwealth.

A young man, thoroughly conversant with home farming methods, would have less to learn about his calling in New Zealand than in either Australia or Canada. But even here there are varying methods, and it is advisable for the immigrant to spend some months in a farm working for another and acquiring knowledge in the meantime rather than to take up a holding of his own almost immediately on landing.

In this Dominion much of the land is State-owned, and there is a restriction upon the number of acres a man may hold, 5,000 acres being the maximum. In each district there are land offices, and most of the holdings are let on renewable leases. There are no free grants of land in New Zealand, but though much of the land is Crown property there are naturally innumerable privately-owned holdings which may be purchased outright by a practical man with the necessary capital.

Speaking generally, the cost of living in comparison to wages paid is low. Provisions cost much about the same as they do at home, except mutton, for example, which may be bought at from 4d. to 6d. per lb. retail. Clothing is a good deal dearer, but farm labourers, milkers, harvestmen, shepherds, grooms and so on are paid rather over £1 per week, with their board. The wages of other classes run in very similar proportion.

The hottest part of the Dominion is the northern half of the North Island, which comprises the district of Auckland. Here oranges, lemons, grapes, maize and similar

MAP OF NEW ZEALAND.

A country which offers many attractive opportunities to the emigrant possessed of small capital.

almost tropical products are grown. Fruit land and stock-keeping land hereabouts costs from £5 an acre upwards to buy, and dairy-farm land from £10 an acre. There are coal mines in this district, and competent pitmen should be sure of securing work without great delay. A working farmer in these parts, with a wife and daughters who would work also, might successfully start on a few acres with a capital of about £100.

The district of Wellington occupies the south of the North Island. Besides possessing a most healthy climate, it offers an enormous quantity of first-rate land. It is mainly a pastoral district, well suited for small farm settlers, and a man could well begin here on 200 acres with a capital of £100.

In the eastern part of the South Island

comes the valuable Canterbury district, which is known all over the world for its sheep. It is also a splendid grain-growing district and dairying is carried on extensively, butter and cheese being dispatched to Great Britain in large quantities. Otago, at the southern part of the South Island, is a large sheep-farming, dairying and mining district and there is some fine fruit land here.

New Zealand is essentially the country of small-holders, and men with a capital of from £100 to £400 can be certain, not only of earning a good living, but also of a prosperous future. So far as the cost of reaching the Dominion from Great Britain is concerned, the fare may be ascertained from any shipping office and the voyage out occupies seven or eight weeks. It is best to arrive in the Dominion from September to January, that is to say, during the early summer, for the New Zealand seasons are precisely opposite to ours.

There are no free passages granted ; but for certain classes of emigrants reduced passages are available, and with other classes the fare may be advanced, to be repaid by instalments when the settler reaches his new home. Full particulars of all these matters may be obtained free of charge by intending emigrants from the *New Zealand Information Bureau*, 13 *Victoria Street, London, S.W.*, the office for the High Commissioner of the Dominion.

In New Zealand, as in most other British overseas dominions, there is little room for clerks, unless they have had colonial experience. Music teachers, governesses and shopmen also may find it difficult to obtain posts. At the same time, there are certain opportunities for the professional classes, but in every case such people should either have an appointment to which to go or friends in the Dominion who would come to their assistance in making a commencement. It is little use for anyone, other than farmers and agricultural workers and domestic servants, going to New Zealand in the hope of something " turning up."

Perhaps the greatest opportunity of all is for fruit farmers, and the following authenticated figures concerning an apple orchard near Nelson, which is north of the South Island, are worthy of notice :

Area in apples. 7 acres.
Produce for the 1913 season, 3,000 cases.
Average price received per case 7s.
Average produce per acre £150.
Average produce per tree 23s.

SOUTH AFRICA.—The Union of South Africa includes Cape Colony, Natal, Transvaal and the Orange River Colony, and the total area of the Union is four times that of Great Britain and Ireland ; whilst of a population of about six millions nearly five millions are made up from coloured races.

Naturally this preponderance of coloured people has a most important bearing on the subject of emigration to South Africa, owing to the employment of coloured labour on farms, on the railways, in the mines, and in every branch of industry. It is only of recent years that the prejudice against the common forms of manual labour has begun to leave the white man's mind. Another point which the would-be emigrant must not overlook is that the Dutch language is very largely spoken, and that farmers and others in the back-blocks of the Colony who have to market their produce and otherwise mingle with the local business community must possess a working knowledge of the Dutch vernacular.

So far as climate goes, South Africa is, generally speaking, very healthy, and, though the temperature rises to great heights, the fact that the air is perfectly dry makes the heat bearable. Away from the sea, however, the nights are frequently bitterly cold. There are only two seasons, the rainy season which lasts from September to March, and the dry season from April to August.

For unskilled general labourers there is very little demand, and even in the mines coloured labour predominates. Mechanics, too, are cautioned against going to South Africa unless they have a situation engaged for them. Again, clerks and shopmen fresh from home are hardly wanted at all.

School teachers are in demand, and should make application to the departments of education at the different large centres, but railway men should not go out, except in response to advertisements in the newspapers at home. Female domestic servants of course are wanted, as they are wanted in all our colonies, but there is no special request for nurses, even when they are highly-trained and certificated.

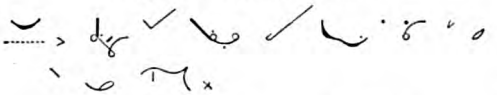
The real and main demand of the Colony is, as a matter of fact, principally concerned with farmers, and before making up their minds intending farmer-emigrants should communicate with the departments of agriculture of either or all of the four Provinces. Fruit farming, stock raising and general mixed farming are the branches that offer the best prospects, but market gardening is in the hands of the coloured races A. C. M.

SHORTHAND.—V

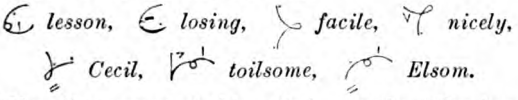
Key to Exercise 21

1. emphasise, emphasises, emphasis, necessity, excessively, successive, masterpiece, elastic.
2. passage, receipts, scarcely, opposite, sixty, testing, justifies, artistic.
3. *The* chemist *speaks specially of-the* necessity *of* taking *several* doses *each* day.
4. *We ourselves suggested the subject be given to* Leslie Rawnsley *of* Chester.
5. *They themselves* sold-*the* pencils *to-the* firm *at* Moseley.
6. *He* read *a* sketch *of-the* life *of-the saviour of* Italy.

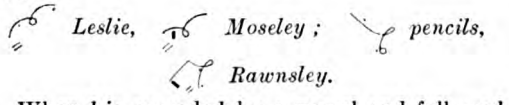
Key to Exercise 22

1. 
2.
3.
4.

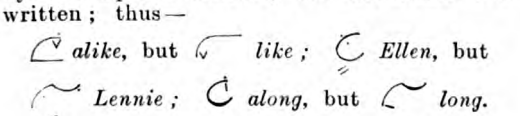
Upward and Downward L.—In Exercise 21, Lesson 4, there are the words *Leslie, Moseley, pencils, Rawnsley,* and the student may have asked why the upward *l* in the first two, and downward *l* in the last two. When the stroke *l* precedes a circle and curve, or follows a curve and circle, it is written in the same direction as the circle; thus—


lesson, losing, facile, nicely, Cecil, toilsome, Elsom.

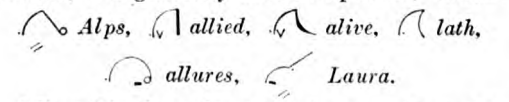
The observance of this rule is simply following the easier way of writing such forms, and is thus in agreement with the rules of writing; hence—


Leslie, Moseley; pencils, Rawnsley.

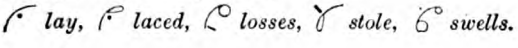
When *l* is preceded by a vowel and followed by a simple horizontal, the downward *l* is written; thus—


alike, but *like; Ellen,* but *Lennie; along,* but *long.*

When, however, *l* is the first stroke in an outline, it is generally written upward; thus—


Alps, allied, alive, lath, allures, Laura.

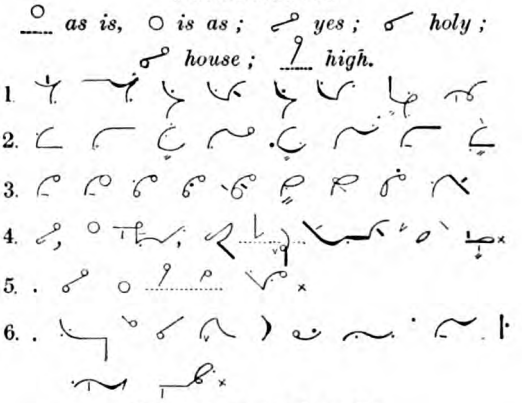
When *l* is the only stroke in an outline, it is always written upward; thus—


lay, laced, losses, stole, swells.

Gathering up the rules for the writing of upward and downward *l*, it is to be noted that one of two broad principles governs the choice of sign: (*a*) Easiness of outline; (*b*) Vowel indication.

Exercise 23

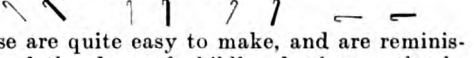
GRAMMALOGUES


as is, is as; yes; holy; house; high.

Key to Exercise 23

1. only, kingly, fell, fellow, vale, valley, Tinsley, muscle.
2. elk, lack, Allen, lance, Ealing, ling, log, Olga.
3. loss, losses, sells, slays, swallows, Lester, lustres, steals, elbow.
4. *Yes, as-is* customary, *we-shall-be at-the sea*-side bungalow *on-the first of* August.
5. *The house is-as high as-the* palace.
6. *The* effect *of-his holy* life *was* seen many *a* long day among-*the* choristers.

Hook R.—Here are the first eight strokes of the alphabet with a hook—



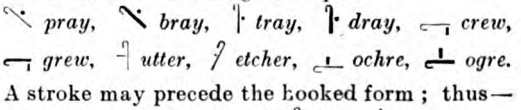
These are quite easy to make, and are reminiscent of the days of childhood when pothooks had to be written. In each case the hook adds *r after* the stroke to which the hook is attached, and thus, the above forms represent—

pr, br, tr, dr, chr, jr, kr, gr

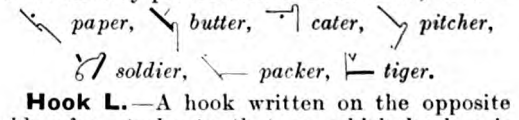
respectively. The hooked forms are to be called by the one-syllable names—

per, ber, ter, der, cher, jer, ker, ger.

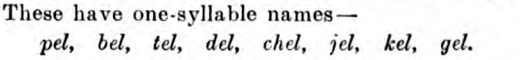
Notice the following examples—


pray, bray, tray, dray, crew, grew, utter, etcher, ochre, ogre.

A stroke may precede the hooked form; thus—


paper, butter, cater, pitcher, soldier, packer, tiger.

Hook L.—A hook written on the opposite side of a stroke to that on which hook *r* is written, adds *l after* the stroke; thus—


pl, bl, tl, dl, chl, jl, kl, gl.

These have one-syllable names—

pel, bel, tel, del, chel, jel, kel, gel.

The following are examples—

play, *blow*, *clue*, *glue*, *apple*, *Abel*, *addle*, *eagle*, *Mabel*, *table*, *feeble*, *hobble*.

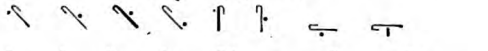
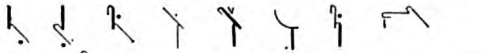
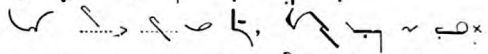
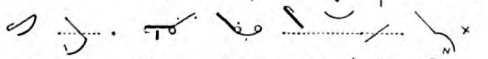
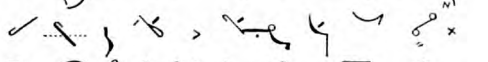
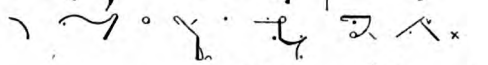
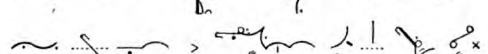
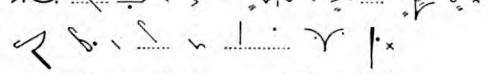
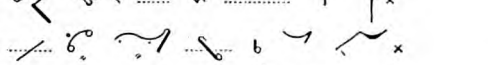
Notice the following examples in which both *r* and *l* hooks occur—

triple, *crackle*, *clapper*, *treacle*, *clatter*, *draggle*.

Exercise 24

GRAMMALOGUES

apply, *people*; *by all*, *able*, *belief-ve-d*.

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
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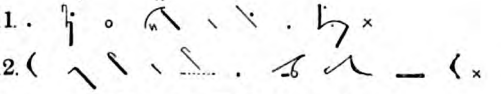
12. 

Key to Exercise 24

1. apple, pray, bray, plea, addle, tray, clay, crow.
2. deeper, deeply, draper, petal, bridle, fiddle, trader, cropper.
3. *If-you*-will *apply to-the people next* door, *they*-will-*be-able to-get you-the* glasses.
4. *We-shall* push *the* grocery business *by-all in our* power.
5. *We believe he-was* opposed *to-the* progressive vote *in-the House.*
6. *Your* manager *has* produced *an* exceedingly gracious reply.
7. Many *people* came *to-the* Chrysanthemum Show *at* Bristol *House.*
8. *We-shall-be* pleased *to apply to-you at an* early date.
9. *Our* Sales Manager *believes he-is in-the* wrong.
10. *He* bought *a* fiddle *of* rare value.
11. *The* trader *is* liable *to* pay *the* damage.
12. *They should-be able to apply the* rules *we-have given them.*

Hooks to Curves.—A small initial hook inside a curve adds *r*, a large initial hook inside a curve adds *l*; thus—

fr, *fl*; *vr*, *vl*; *thr*, *thl*; *shr*, *shl*; *nr*, *nl*; *mr*, *ml*.

Examples—

Fred, *fled*; *Trevor*, *trifle*; *ether*, *Ethel*; *tanner*, *tunnel*; *calmer*, *camel*; *hammer*, *Hamel*.

Any of the forms hooked for *r* or *l* may be used to represent syllables; thus—

nervous, *terms*, *germs*, *girl*, *fervour*, *chivalry*, *playful*, *panel*, *grapnel*, *signal*, *nominal*, *penalty*, *Cheshire*.

Exercise 25

GRAMMALOGUES

doctor, *Dr.*, *dear*, *during*; *call*, *equal-ly*.

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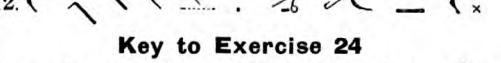
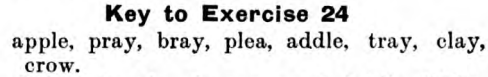
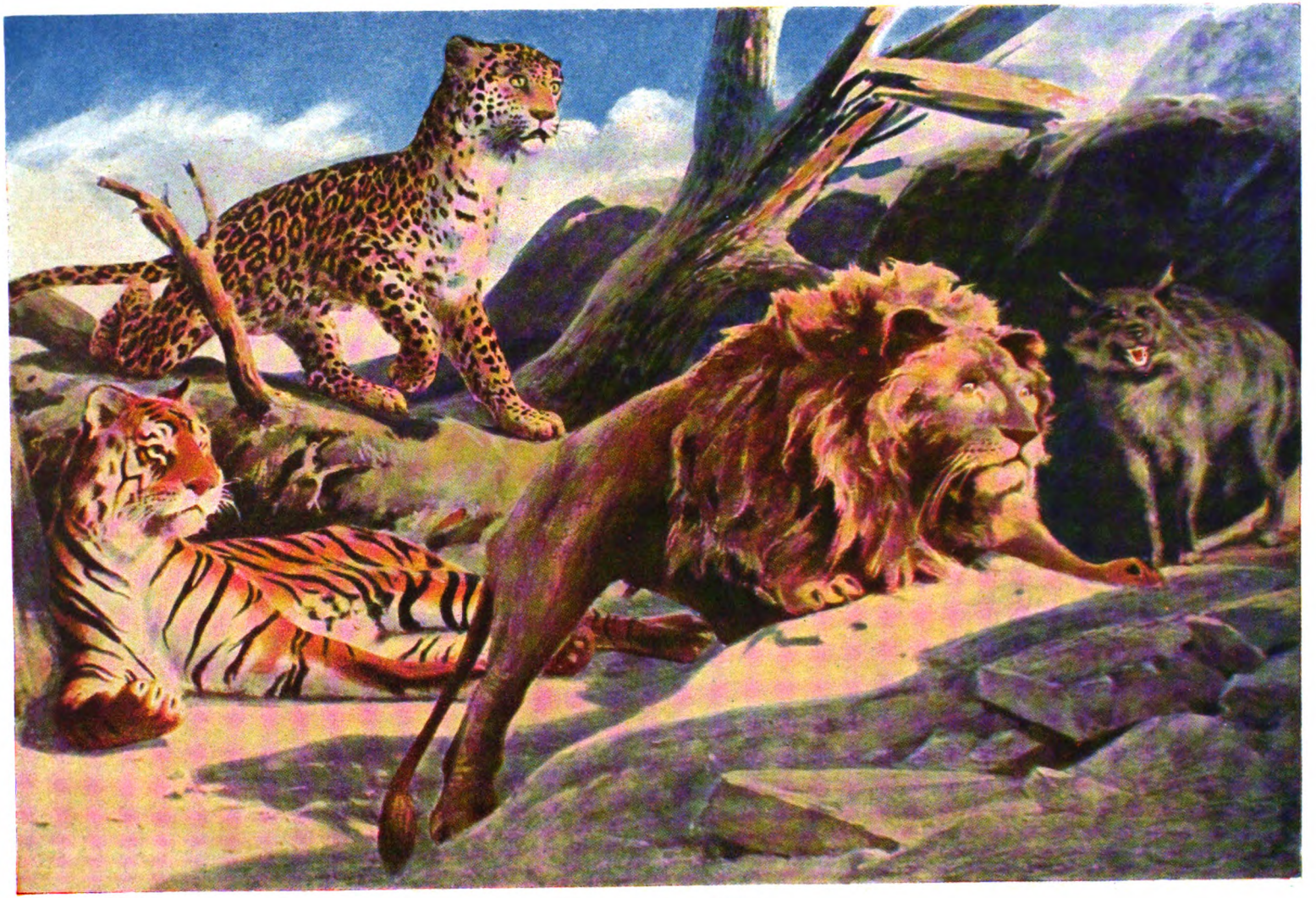
2.
3.
4.
5. 
6. 

Exercise 26

GRAMMALOGUES

for; *over*, *ever-y*, *however*; *other*.

1. Frank, flank, average, fledge, finer, funnel.
2. trainer, panel, kennel, keener, Chivers, joyful.
3. *For over a year we-have given your* books favourable reviews *in our* magazines.
4. *Every* person seems-*to-be in a* fever *over-the* delay *of-the* steamer.
5. *You-should, however, see to-the* making *up of-the other* packages *if-you wish no* delay.
6. *For every* such customer *we-have ever* lost, *we-have-had, however, over* five *others to* add *to-our* list.



A GROUP OF CARNIVORA.

Reading from left to right, the beasts shown are:—a Tiger; a Leopard; a Lion; a Hyena. (*See Zoology, pages* 466 9.)

Continued from page 390.

ENGLISH LANGUAGE AND LITERATURE:

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THE DRAMA BEFORE SHAKESPEARE

THE writing life of William Shakespeare, the world's greatest literary genius, balanced around the year 1600. From twelve years before that date till twelve years after it he was pouring forth the incomparable plays that have made him immortal in the minds of men. Not only did the English drama reach in him its supremest heights, but also the drama of the world.

Apart from Shakespeare the period would have been conspicuous in England for the grace and power of its literary expression; but in pure poetry, in dramatic grandeur, and in profundity of thought, Shakespeare outranges the collective genius of his age.

An amazing feature of the Elizabethan drama is the rapidity with which it developed.

The first English comedy, rounded and completed consciously for acting, was not written till about ten years before the birth of Shakespeare; and the first tragedy three years before his birth. But for four and a half centuries there had been a slow evolution of crude forms of dramatic representation, some of which have persisted in England, with ever-increasing degeneration, to our own day, as rustic revels, and abroad have been sustained as religious tableaux.

Miracle Plays

In the dark ages of mediævalism the classical drama, produced by Greek thought and art, and demolished under Roman influence, ceased to exist. The Church frowned upon all theatrical displays, and indeed forbade them, until it became advisable to use them for its own purposes.

As few of the laity could read, and the Scriptures were almost wholly in Latin, it was convenient to place the Biblical narratives before the people in a visualised form, and so the characters and stories of Hebrew, Christian, and ecclesiastical history were rudely dramatised and acted, under the supervision of the clergy.

These representations were given chiefly at fixed periods of the year, such as Christmas, Easter, and, later, the Corpus Christi festival. Miracle plays, including gleanings from the lives of saints and martyrs, popularised in the same way many of the traditions of the Church.

Allegorical Drama

Gradually the acting of these religious scenes, linked together so as to make a kind of narrative, passed into the hands of the guilds of handicraftsmen. Thus, the boat-builders represented the making of Noah's ark, and the goldsmiths the adoration of the infant Christ by the wise men from the East.

In some of the towns, as, for example, in York, Wakefield, Beverley, Chester, and Coventry, series of these scenes, with a rhymed accompaniment, gave a panoramic survey of religious history, and in many cases they have been preserved in manuscript and form complete cycles of primitive plays. More than a hundred of these plays are extant.

Later, in the fifteenth and early sixteenth centuries, when poetry was largely taking the form of Allegory, and when scenes from the Scriptures, now much better known, were becoming stale, the miracle plays were gradually replaced by what were called *Morality Plays* and *Interludes*, the *Morality* being a drama in which the characters were Virtues and Vices, while the *Interlude* was a farce used for comic relief. Truth, Ignorance, Hypocrisy, Luxury, Avarice, Wit, and Tediousness may be mentioned as typical

characterisations, and an impish devil, the spirit of mischief, on which the name of Vice was eventually bestowed, was the most inevitable and popular of the comic apparitions. The knock-about clowns and harlequins of modern pantomime are degenerate survivals from the humours of the Moralities and Interludes.

The best known of the Interludes is John Heywood's *Four P's*, in which a Palmer, Pardoner, Potecary (Apothecary) and Pedlar compete in telling incredible tales, and the Palmer wins by saying he never saw a woman out of patience. It was first acted about the year 1543.

Though in scarcely any of these early plays can the most fugitive literary value be discovered, for they limp painfully along in rhymed doggerel, yet they are interesting as throwing light on the simplicity of early English beliefs and humours; and one of them, *Everyman*, is made powerfully impressive by the sustained gravity of its treatment of a solemn theme—man's final hour on earth.

Touring Companies

By the middle of the sixteenth century two changes began to affect the English drama vitally. First, as one of the fruits of the revival of the ancient learning, the Greek drama was discovered, and with it came Tragedy. Secondly, acting passed from the artisans of the towns to professional companies formed under the protection of noblemen.

These companies were licensed not only to act as part of the entourage of their patron, but also, by local leave, could tour the country. A company was attached to the Court itself when Elizabeth came to the throne.

English comedy based on English life began about 1553 with the writing of the rollicking play *Ralph Roister Doister*, the author being Nicholas Udall, a Hampshire man, educated at Oxford, who was headmaster first of Eton and then of Westminster. The play, a rather violently active jest, was designed for performance by boys, and suited the boyish sense of humour.

Tragedy had its introduction about 1560 in translations of Seneca, and the first original English play in the tragic vein was an imitation of Seneca's methods and style. This was *Gorboduc*, by Thomas Sackville and Thomas Norton, a dull, gloomy piece, but memorable for bringing blank verse into use as the measure natural to the serious drama. It was first acted in 1561, by "the gentlemen of the Inner Temple."

Not till the "seventies," and still more the "eighties," of the sixteenth century could it be said there was a development of the drama giving full scope for the professional actor, in an age grown intellectually alert; and there was no permanent theatre for Londoners till 1576, when Shakespeare was a lad of twelve in Warwickshire. Neither then nor for many years was a theatre allowed in London.

The original "Theatre," built in 1576, was in Shoreditch, and its founder was James Burbage, one of the Earl of Leicester's players, and father of Richard Burbage who afterwards acted the leading parts in Shakespeare's plays. Later, the Burbages owned the "Rose," on the south of the Thames, the "Blackfriars," outside Lud Gate, and in 1599 built the "Globe," in Southwark, with Shakespeare as a prominent shareholder.

In the same year the Fortune Theatre, which stood until 1819, was built by Richard Alleyn, the actor, between Whitecross Street and Golden Lane. These early theatres had no connection, architecturally, with those of classical times. They were evolved naturally from the primitive custom of erecting a stage in the courtyard of an inn, the gallery around the courtyard serving as the boxes, while poorer patrons stood in the court on all sides of the stage to witness the play.

In these and other theatres the demand for plays during the last dozen years of the century was incessant. How was it supplied?

The "University Wits"

The storylands of the classics and of Italian literature were ransacked for subjects, and plays once produced were recast without any regard for the sensibilities of the original authors; but no names of playwrights of any account occur until the arrival in London of a group now commonly known as the "University Wits." All these men were contemporary with Shakespeare in his youth, but preceded him somewhat as playwrights. Some of them have been mentioned already as writers of our first prose fiction. John Lyly, who wrote masques rather than plays, but had a considerable influence on the stage, was Shakespeare's senior by ten years. Thomas Nash, Thomas Lodge and Thomas Kyd (the last not a University man) were three years younger than Lyly. George Peele was six years and Robert Greene four years older than Shakespeare; and Christopher Marlowe and Shakespeare were born

A FOURTEENTH-CENTURY MYSTERY PLAY.

In an age when very few of the laity could read and the Scriptures were wholly in Latin, the Church welcomed the idea of presenting to the people in the market-places of England—under the supervision of the clergy—dramatised versions of the Bible stories. From these crude representations was evolved the English drama.

in the same year. Though Shakespeare died at an age that would now be regarded as young, he outlived by ten years or more all these contemporary authors except Lodge.

The "Wits" started a vogue in writing, both lyrical and dramatic, which Shakespeare adopted, expanded and perfected. He found them first his inspirers, then his collaborateurs, and later, in some instances, his rivals. Living reckless lives they fell early out of the race, while he went on, with new associates, to amass for his age such glories as no one could sustain after his death.

Christopher Marlowe

Of those writers who immediately preceded Shakespeare's use of the pen, one only wrote plays that still appeal to the reader. On the work of Christopher Marlowe, the true founder of our drama, if we regard its spirit as well as its form, Shakespeare modelled his early writing.

Lyly, Peele, Greene and Lodge were all skilful in weaving graceful lyrics into their dramas. Lyly used prose freely, while Peele showed a progressive mastery of blank verse. Greene brought plays into closer touch with the life of the day, and mingled comedy with tragedy. Lodge made an advance in the clear delineation of character.

Christopher Marlowe, son of a Canterbury shoemaker, took the town by storm, when he was three-and-twenty, with his powerful rhetorical *Tamburlaine the Great*. During the next six years, till he was killed in a tavern brawl in 1593, he was writing plays with increasing power and variety, each expressive of some master passion or weakness.

The *Tamburlaine* pictured unbridled ambition; and it was followed by a study of the pride of learning and inquiry in *The Tragical History of Dr. Faustus;* of the passion of avarice in *The Jew of Malta;* and, finally, in *Edward II.*, the first English play that can be regarded seriously as historical. Later, he probably collaborated with Shakespeare in the three parts of *Henry VI.*, and, possibly, in *Titus Andronicus.*

Not only did Marlowe bring an entirely new vigour into the English drama, making it a medium of intellectual power, which held attention and commanded respect, but he established blank verse, once for all, as the most dignified English measure. Though his writing had too much "sound and fury," too little light and shade, and was also lacking in humour, his forceful genius had far-reaching effects, and his early death is one of the tragedies of literary history.

J. D.

THE ENGLISH LANGUAGE.—V

THE verb is the word which expresses action or makes a statement, and it is the indispensable part of the predicate in every sentence.

A verb is called **transitive** when the action passes from the subject to another noun or pronoun, called the object; when the action is limited to the subject the verb is called **intransitive,** e.g.:—

The boy *eats* the apple [transitive].
The apple *fell* [intransitive].

Certain verbs may be either transitive or intransitive, according to their use in particular circumstances. Thus the verb *sink* is usually intransitive, but is transitive when it is used in a causal sense, as in—

They sank the ship [= They caused the ship to sink].

So, *run* is properly intransitive, but may take an object of kindred meaning (cognate object), as in "I ran a race." In the opposite direction transitive verbs may become intransitive when they are used in a general sense or when their object—usually a reflexive pronoun—is left to be inferred, e.g.:—

The man smokes [cf. He smokes a pipe].
The earth moves [cf. I move the chair].

Some verbs do not make a complete statement without the help of a complement; such verbs are known as verbs of incomplete prediction, and they may be transitive or intransitive, e.g.:—

They *made* him a *general* [transitive].
He *seemed clever* [intransitive].

Auxiliary Verbs

Certain verbs of incomplete predication are used as auxiliary verbs which take the place of inflexions in the formation of tenses, etc. The commonest of these are *be, have, will, shall, may, might, would, should, can.* These verbs may be the finite verb in the grammatical sense; but they do not act as verbs of complete meaning, and require a second verb in order that an assertion may be completely made, e.g. "He *is* hurt," "I *have* spoken," "He *will* go." Nevertheless some of them may be used, not as auxiliaries, but as verbs of complete meaning, e.g. "The boy is here," "I have a book," "The Kaiser willed the war."

In English, transitive verbs always govern the objective case; but many of them take an indirect object in addition to the direct object. Properly the indirect object should be in the dative case, but it is usual to regard

it as objective after an understood preposition *to* :—

He gave the boy an apple = He gave an apple to the boy.

A noun or pronoun used as a complement is in the nominative or objective case according as it is in apposition with the subject or object respectively :—

He became *king* [nominative].
The people made him *king* [objective].

Voice

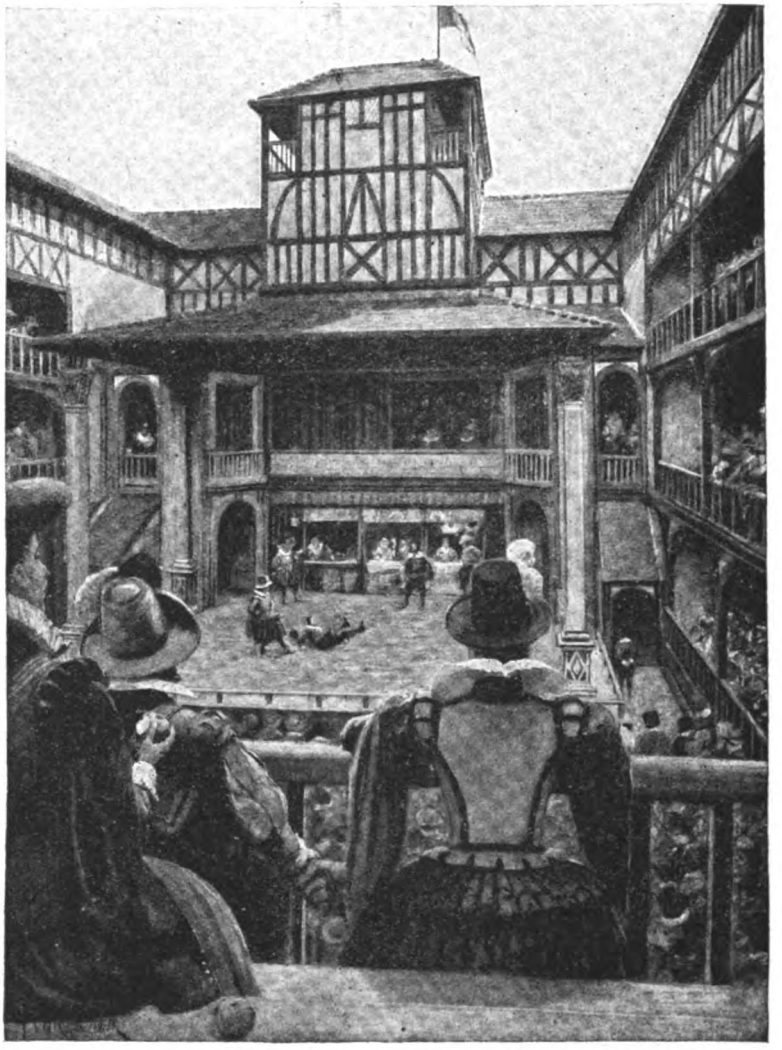
When the subject of a verb is the doer of the action expressed by the verb, the verb is said to be in the active voice ("I strike"); but sometimes the subject is really the sufferer of the action ("I was struck"), and the verb is then said to be in the passive voice. Only transitive verbs can properly be used in the passive voice; for obviously the subject of the passive verb is the object of the same verb in the active voice, e.g. "*I* was struck" = "Somebody struck *me*." Yet there are many intransitive verbs which have a transitive sense when used along with a preposition; and such verbs may form a passive if the preposition is regarded as an inseparable part of them, e.g. :—

They *laugh at* the man [active].
The man *is laughed at* [passive].

This usage is freely employed in modern English, but it is often inelegant and should be avoided as far as possible: an active construction is preferable to such expressions as "The chair was sat upon," "The prize was competed for," "The hedge was leapt over," and their like.

The full list of the inflexions and other changes undergone by a verb in forming its various moods and tenses is called the conjugation of the verb. There are two methods of conjugation, differing from one another in the method of forming the past tense and past participle, but not in other ways.

(1) The strong conjugation is the older method, and is not now applied to new verbs. The past tense is formed by changing the vowel of the present without any addition to the stem, as *sing—sang, break—broke*. The past participle is sometimes the same as the past tense, as *find—found*—have



THE FORTUNE THEATRE,
which stood until 1819, was built in 1599 by Richard Alleyn, the actor, between Whitecross Street and Golden Lane, London.

found ; sometimes has a different vowel, as *sing—sang*—have *sung ;* and sometimes has the inflexion *-en*, which was in O.E. universal, in addition to vowel-change, as *speak—spoke*—have *spoken*. The termination *-en* still survives in archaic forms like *bounden, sunken, shrunken, molten*, which are now used only as adjectives, the true participle dropping the inflexion.

The student must distinguish carefully between the past tense and the past participle, and avoid such a mistake as "I have spoke." The following strong verbs should be especially noted, and the forms looked up in a dictionary where there is any doubt about them : *Bear, beat, bid, blow, eat, fly, hide, lie, ride, rise, slay, smite, strike, strive.*

(2) The weak conjugation forms both past tense and past participle by the addition of the inflexion *-ed*, with such modifications in spelling as are suggested by the rest of the word ; e.g. *work—worked ; love —loved ; say—said ; carry—carried ; prefer preferred.* Sometimes we have *-t* instead of *-d*, as in *send—sent ; learn—learnt.* Sometimes, when the present ends in *-d* or *-t*, no addition is made for the past, e.g. *put—put*, though this is not universal—e.g. *sweat—sweated ; flit—flitted ;* and in some cases the root-vowel is shortened, as in *lead—led ; read—read.* A few familiar weak verbs have vowel-change as well as the inflexion : *sell, tell, think, seek, catch, buy, teach* are examples.

Anomalous Verbs

All new verbs in the language are of the weak conjugation, and there is a tendency, even among the common strong verbs, for weak forms to creep into use. The use of *hanged* instead of *hung* has become quite regular in one familiar connotation ; and the following verbs all have weak as well as strong forms : *Awake, cleave, mow, sow, sew, show, flow, thrive, shear, strew.*

(3) Anomalous verbs are those which apparently follow no regular rule of conjugation : they include (*a*) verbs like *to be*, which have borrowed the forms of quite different verbs, e.g. *was* comes from a different root from *is* ; and (*b*) the auxiliaries *shall, may, will, can*, which have become greatly modified by use ; (*c*) such verbs as *dare* (past tense, *durst*), *ought* (formerly past tense of *owe*). These verbs do not share the inflexional forms for number and person that are found in other verbs ; e.g.—*cf.* "He *dare* not go," with "He *likes* to go." *Shall, will, may, can* were originally past tenses, and consequently do not take the inflexion *-s* in the third person. No special inflexion survives in the third person of the past tense : *cf.* "He *loves*" with "he *loved*," "he *sings*" with "he *sang.*"

The only other inflexions in use in verbs are : (*a*) the *-est* or *-st* of the second person singular, as in "thou *lovest*," now archaic ; (*b*) the *-ing* of the present participle and the verbal noun, formerly quite distinct terminations ; (*c*) in the subjunctive mood proper the inflexions of the indicative are dropped, but as has been previously mentioned the subjunctive forms are not much used.

Adverbs

An adjunct of the verb is called an adverb ; e.g. "He sang *well.*" The adverb may also be used to modify an adjective or another adverb, or even a preposition or conjunction ; e.g. "He is *very* good" ; "He sang *quite* loudly" ; "The stone lay *partly* in the water."

Adverbs express time (*now, to-day*), place (*here, upstairs*), manner (*sweetly*), degree (*entirely, quite*), negation (*not, never*), cause (*why ?*). They are often associated with corresponding adjectives, from which they are formed by the addition of the suffix *-ly*, e.g. *fair—fairly.* Others have been formed from pronouns, e.g. *here, there, where ;* while still others have been originally phrases which have coalesced into single words, e.g. *upstairs, to-morrow, outside.* The suffix *-wards*, as in *earthwards*, is still a living one.

Adverbs may be compared, when their meaning allows it, by the same methods as adjectives, e.g. *early — earlier — earliest ; badly—worse—worst.*

It is important to distinguish between adjectives and adverbs, and not to perpetrate the blunder seen in "He spoke loud" (loudly). In a few instances, however, the adjective is legitimately used for the adverb ; e.g. "His words rang *true*" ; "The flowers smell *sweet*" : strict usage demanding *truly* and *sweetly* would be pedantic in these cases.

The objective case of nouns is often used adverbially to denote extent of time or space ; e.g. "He worked *all day*" ; "He ran *five miles.*" This usage is known as the adverbial accusative, and is found in Latin, as well as English.

Adverbs are generally placed before the word they modify, but there are many exceptions to this assertion, and it never applies to adverbial phrases. Thus we write : "He was *almost* dead" ; "I never came" ; but also "He died *yesterday*" ; "I came *quickly.*" So we have "He has *completely* disappeared" and "He was found *there.*"

E. W. E.

Continued from page 400.

HISTORY:

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BRITAIN'S STORY.—II

[*The introductory chapter to* LORD MACAULAY'S "*History of England*" *has been adopted in this work to explain the development of the British race prior to* 1660. *But as Lord Macaulay's work was intended merely as a sketch, explanatory passages* (*printed in closer type*) *have been interpolated in order to meet the requirements of the student.*]

WHATEVER reproach may, at a later period, have been justly thrown on the indolence and luxury of religious orders, it was surely good that, in an age of ignorance and violence, there should be quiet cloisters and gardens, in which the arts of peace could be safely cultivated, in which gentle and contemplative natures could find an asylum, in which one brother could employ himself in transcribing the Æneid of Virgil, and another in meditating the Analytics of Aristotle, in which he who had a genius for art might illuminate a martyrology or carve a crucifix, and in which he who had a turn for natural philosophy might make experiments on the properties of plants and minerals. Had not such retreats been scattered here and there, among the huts of a miserable peasantry, and the castles of a ferocious aristocracy, European society would have consisted merely of beasts of burden and beasts of prey.

The Ark of Civilisation

The Church has many times been compared by divines to the ark of which we read in the Book of Genesis; but never was the resemblance more perfect than during that evil time when she alone rode, amidst darkness and tempest, on the deluge beneath which all the great works of ancient power and wisdom lay entombed, bearing within her that feeble germ from which a second and more glorious civilisation was to spring.

Even the spiritual supremacy arrogated by the Pope was, in the dark ages, productive of far more good than evil. Its effect was to unite the nations of Western Europe in one great commonwealth. What the Olympian chariot course and the Pythian oracle were to all the Greek cities, from Trebizond to Marseilles, Rome and her Bishop were to all Christians of the Latin communion, from Calabria to the Hebrides.

Thus grew up sentiments of enlarged benevolence. Races separated from each other by seas and mountains acknowledged a fraternal tie and a common code of public law. Even in war, the cruelty of the conqueror was not seldom mitigated by the recollection that he and his vanquished enemies were all members of one great federation.

In the Train of Christianity

Into this federation our Saxon ancestors were now admitted. A regular communication was opened between our shores and that part of Europe in which the traces of ancient power and policy were yet discernible. Many noble monuments which have since been destroyed or defaced still retained their pristine magnificence; and travellers, to whom Livy and Sallust were unintelligible, might gain from the Roman aqueducts and temples some faint notion of Roman history.

The dome of Agrippa, still glittering with bronze, the mausoleum of Adrian (now called the Castle of San Angelo), not yet deprived of its columns and statues, the Flavian amphitheatre (i.e. the famous Colosseum at Rome), not yet degraded into a quarry, told to the rude English pilgrims some part of the story of that great civilised world which had passed away. The islanders returned, with awe deeply impressed on their half-opened minds, and told the wondering inhabitants of the hovels of London and York that, near the grave of Saint Peter, a mighty race, now extinct, had piled up buildings which would never be dissolved till the judgment day.

Learning followed in the train of Christianity. The poetry and eloquence of the Augustan age was assiduously studied in Mercian and Northumbrian monasteries. The names of Bede and Alcuin were justly celebrated throughout Europe.

Such was the state of our country when, in the ninth century, began the last great migration of the northern barbarians.

During many years Denmark and Scandinavia continued to pour forth innumerable pirates, distinguished by strength, by valour, by merciless ferocity, and by hatred of the Christian name.

No country suffered so much from these invaders as England. Her coast lay near to the ports whence they sailed; nor was any shire so far distant from the sea as to be secure from attack. The same atrocities which had attended the victory of the Saxon over the Celt were now, after the lapse of ages, suffered by the Saxon at the hand of the Dane. Civilisation, just as it began to rise, was met by this blow, and sank down once more.

Large colonies of adventurers from the Baltic established themselves on the eastern shores of our island, spread gradually westward, and, supported by constant reinforcements from beyond the sea, aspired to the dominion of the whole realm.

The first stage began with the devastation of Northumbria in 787. Every year after that saw fresh swarms of pirates pillaging our coasts.

Not only England, but all Northern Europe, was exposed to those inroads, and as the triumphs of Charlemagne had made access to North Germany difficult, it was by sea that they commonly went on their forays. Their object was mainly plunder. Settlement or conquest was impossible, Scandinavia being cut up into too many petty states to make possible the degree of cohesion necessary for combined efforts.

Roving Vikings

But within a century of the first inroads of the Vikings, a great revolution occurred in Scandinavia. Powerful kings arose in the north, and subjected to themselves the wide districts that became known as Norway, Sweden, and Denmark. The *jarls*, or petty kings, who ruled over the various districts, were crushed, therefore, into dependencies on a new centralising national power. It was the same process that was consolidating England, and which became the source of the national idea.

But, just as happened in England and Germany, the new development proved a deadly foe to the primitive Teutonic polity. All conservative instincts revolted against the degradation of the sovereign *jarl* to the condition of personal subordination to the new monarch. The best and bravest of the Northmen abandoned their native land, and sought to win by their swords a new home for their polity.

Hence the great Scandinavian migrations of the ninth century. Again the Northmen poured into England, and by the end of the century one half of

the country was Danish. Between 867 and 869 Northumbria, long distracted by anarchy, fell into the hands of the pagan invaders. In 868 Mercia was overrun; in 870 East Englia; whilst in the following year the ruling kingdom of the West Saxons was invaded.

King Ethelred I., however, in a brilliant series of hard-fought battles, taught the invader that Wessex was not so easy a prey as the subject states. When Ethelred died in the middle of the contest, his brother Alfred kept up the struggle, and succeeded in clearing his own territory at the expense of the overlordship won by Egbert.

A fresh invasion of Wessex in 878 taxed Alfred's resources to the utmost limit, but he fought desperately, and continued somehow to preserve his independence, finally forcing the enemy to conclude the Peace of Wedmore—a treaty that acknowledged the *status quo* and gave the Danes all the land north-east of Watling Street, i.e. Chester to Hertford, and the Lea and Lower Thames.

Danish England

Meanwhile, other swarms of Vikings colonised the Orkneys, Shetlands, Faroe, Hebrides, and the southern isles as far as Man, and in Caithness and Sutherland effected a settlement on the mainland. Bolder spirits sought homes in hitherto desert Iceland, some crossing, it is believed, even to the mainland of the American continent.

Other bands of Vikings invaded Gaul, where they won Normandy from the Carlovingians; whilst eastward over the Baltic a Viking dynasty was founded in Russia, and the terror of the Scandinavian name spread even to the court of the Eastern Emperors.

The Peace of Wedmore began a new period in the relation between the English and the Danes. For a century we hear little of fresh invasions from beyond the sea, but a constant war went on between the Danes in England and the West Saxon monarchs who endeavoured to subdue them.

The struggle between the two fierce Teutonic breeds lasted through six generations. Each was alternately paramount. Cruel massacres followed by cruel retribution, provinces wasted, convents plundered, and cities rased to the ground, make up the greater part of the history of those evil days.

At length the North ceased to send forth a constant stream of fresh depredators; and from that time the mutual aversion of the races began to subside. Intermarriage became frequent. The Danes learned the religion of the Saxons; and thus one cause of deadly animosity was removed. The Danish and Saxon tongues, both dialects of one widespread language, were blended together. But the distinction between the two nations was by no means effaced, when an event took place which prostrated both, in common

By permission of Messrs. Raphael Tuck.

LANDING OF CANUTE.

The most gifted of the Danish chieftains who invaded Britain, and who succeeded during his reign in establishing his supremacy over the greater part of the island.

slavery and degradation, at the feet of a third people—the Normans.

King Alfred, after the conclusion of the Peace of Wedmore, rested content with the acknowledgment of the *status quo;* but a more ambitious policy was adopted by his successors and, as a result of the work accomplished by Edward the Elder, Athelstan, Edred, and the latter s great minister, Dunstan, the supremacy of the West Saxon kings was again established.

On the death of Edred, Ethelred the Unready succeeded to the throne. During his reign everything went wrong. The Danes again became formidable; fresh hordes of invaders poured across the seas, and early in the eleventh century the greater part of the country was brought under the sovereignty of Sweyn, King of Denmark, whose successor, Canute—a really great ruler—succeeded in establishing his sway over the whole land.

Edward the Confessor

In 1035 Canute died. The West Saxon line was then restored in the person of Edward the Confessor. Now, Edward had been educated in Normandy, and was "Continental" in his tastes, predilections, and sympathies. Moreover, he brought with him to England many natives of Normandy, and in more ways than one prepared the way for the Norman Conquest.

Yet Edward the Confessor was beloved by his subjects, and regarded in after ages with a veneration that amounted almost to worship. But the prosperity which characterised his reign gave him a greater reputation as a statesman than he really deserved, the actual work of government being performed by his father-in-law, Earl Godwin, who was responsible to a very much greater extent than was the king for the many famous laws enacted at this time. On the death of Godwin the real power passed into the hands of his son, Harold, whom, at the beginning of 1066, after the death of Edward, the nobles and bishops unanimously elected king. Harold's unlucky reign, however, endured only ten months—from January 6th, 1066, to October 14th of the same year, when he and his Englishmen were defeated at Hastings by William of Normandy, to whom—so the Conqueror asserted—the crown of England had been bequeathed by Edward the Confessor.

The Normans, at the time of the Conquest, were the foremost race of Christendom. Their valour and ferocity had made them conspicuous among the rovers whom Scandinavia had sent forth to ravage Western Europe. Their sails were long the terror of both coasts of the Channel. Their arms were repeatedly carried far into the heart of the Carlovingian empire, and were victorious under the walls of Maestricht and Paris.

At length one of the feeble heirs of Charlemagne ceded to the strangers a fertile province, watered by a noble river, and contiguous to the sea. In that province they founded a mighty state, which gradually extended its influence over the neighbouring principalities of Brittany and Maine.

Without laying aside that dauntless valour which had been the terror of every land from the Elbe to the Pyrenees, the Normans rapidly acquired all, and more than all, the knowledge and refinement which they found in the country where they settled. Their courage secured their territory against foreign invasion. They established internal order, such as had long been unknown in the Frank empire. They embraced Christianity; and with Christianity they learned a great part of what the clergy had to teach.

They abandoned their native speech, and adopted the French tongue, in which the Latin was the predominant element. They speedily raised their new language to a dignity and importance which it had never before possessed. They found it a barbarous jargon; they fixed it in writing; and they employed it in legislation, in poetry, and in romance.

Norman Refinement

They renounced that brutal intemperance to which all the other branches of the great German family were too much inclined. The polite luxury of the Norman presented a striking contrast to the coarse voracity and drunkenness of his Saxon and Danish neighbours. He loved to display his magnificence, not in huge piles of food and hogsheads of strong drink, but in large and stately edifices, rich armour, gallant horses, choice falcons, well-ordered tournaments, banquets delicate rather than abundant, and wines remarkable rather for their exquisite flavour than for their intoxicating power.

That chivalrous spirit, which has exercised so powerful an influence on the politics, morals, and manners of all the European nations, was found in the highest exaltation among the Norman nobles. Those nobles were distinguished by their graceful bearing and insinuating address. They were distinguished also by their skill in negotiation, and by a natural eloquence which they assiduously cultivated. It was the boast of one of their historians that the Norman gentlemen were orators from the cradle.

But their chief fame was derived from their military exploits. Every country, from the Atlantic Ocean to the Dead Sea, witnessed the prodigies of their discipline and valour.

One Norman knight, at the head of a handful of warriors, scattered the Celts of Connaught. Another founded the monarchy of the Two Sicilies, and saw the emperors

both of the East and of the West fly before his arms. A third, the Ulysses of the first crusade, was invested by his fellow soldiers with the sovereignty of Antioch; and a fourth, the Tancred whose name lives in the great poem of Tasso, was celebrated through Christendom as the bravest and most generous of the deliverers of the Holy Sepulchre.

The vicinity of so remarkable a people early began to produce an effect on the public mind of England. Before the Conquest, English princes received their education in Normandy. English sees and English estates were bestowed on Normans. The French of Normandy was familiarly spoken in the palace of Westminster. The court of Rouen seems to have been to the court of Edward the Confessor what the court of Versailles long afterwards was to the court of Charles the Second.

The battle of Hastings, and the events which followed it, not only placed a Duke of Normandy on the English throne, but gave up the whole population of England to the tyranny of the Norman race. The subjugation of a nation by a nation has seldom, even in Asia, been more complete.

The country was portioned out among the captains of the invaders. Strong military institutions, closely connected with the institution of property, enabled the foreign conquerors to oppress the children of the soil. A cruel penal code, cruelly enforced, guarded the privileges, and even the sports, of the alien tyrants.

Yet the subject race, though beaten down and trodden under foot, still made its sting felt. Some bold men, the favourite heroes of our oldest ballads, betook themselves to the woods, and there, in defiance of curfew laws and forest laws, waged a predatory war against their oppressors. Assassination was an event of daily occurrence. Many Normans suddenly disappeared, leaving no trace. The corpses of many were found bearing the marks of violence.

Death by torture was denounced against the murderers, and strict search was made for them, but generally in vain; for the whole nation was in a conspiracy to screen them. It was at length thought necessary to lay a heavy fine on every Hundred in which a person of French extraction should be found slain; and this regulation was followed up by another regulation, providing that every person who was found slain should be supposed to be a Frenchman, unless he was proved to be a Saxon.

From the painting by John Cross.

THE CORONATION OF WILLIAM THE CONQUEROR,

who formally mounted the throne of England at Westminster Abbey on Christmas Day, 1066.

The death of Harold, and the decisive victory gained by the Normans at Hastings, served only to clear from William's path the most formidable of his competitors. The surviving leaders of the nation could not yet be persuaded to elect him King; they chose instead the boy Edgar, Edward the Confessor's rightful heir, and made ready to continue the struggle.

William then took his way by Romney, Dover, and Canterbury towards London, scattered a body of Londoners who tried to check his progress, and set fire to Southwark; but, finding the capital still insubmissive, he was forced to march westward as far as Wallingford before he could effect a passage of the Thames, which in those days, it must be remembered, was bordered with broad, deep marshes.

Having crossed the river, William began to move on London from the north-west. This advance brought his opponents to their knees. They offered him the throne, and on Christmas Day, 1066, William was crowned in Westminster Abbey.

The Conquest might now be thought complete. From the vast estates of Harold, his brothers, and other partisans, William rewarded his followers; but he either left undisturbed or confirmed in their possessions and offices those who had not fought against him, or had submitted. To outward appearance the only material change was a Norman instead of an English king, and the addition to the higher and official ranks of the population of a contingent of foreign nobles, each with a foreign following.

The Norman Conquest

All was quiet; and the King, having deputed the government to his brother Odo, now Earl of Kent, and his friend Fitz-Osborn, now Earl of Hereford, returned with his army to Normandy in March, 1067. But the work of conquest proved to be only half done. Risings broke out all over the country, and William was hastily recalled, only to find that the west and north had still to be subdued.

In 1068 he marched upon Exeter, took it after an honourable resistance, and this brought under his sway the western counties. The northern lands, which were also in rebellion, were awed into transitory obedience by a march upon Warwick; and the conquerors occupied York and Durham.

Again the prospect had cleared. But again it turned out to be illusive. In 1069 the north was once more in arms. The Normans in Durham were slain to a man. York was besieged. The west, moreover, the Welsh border, and parts of the Midlands also sprang to arms.

William's Heavy Hand

Leaving the other centres of insurrection to the industry of his lieutenants, who did not fail him, William took in hand those of the north, and quelled them one by one. The chastisement of the country folk that he deemed necessary, though undoubtedly cruel, grew in the narratives of later writers into a pitiless laying waste of all northern England, into a clearance from this region of every form of life.

"The days of King William," wrote one old chronicler, "were days of vexation and sorrow, so that much people of England thought his life too long." Another chronicler tells us that the Normans "were filled with devils," and how "the land was all ruined by their deeds, and it was said openly that Christ and his saints slept"; whilst a third adds that "not a single habitation was left between York and Durham."

Such statements cannot be regarded as strictly accurate. None the less, William's hand undoubtedly fell heavily, and when he dismissed his troops at Salisbury in March, 1070, the work of conquest practically was done.

AFTER HASTINGS.

Harold's Queen discovers during the night following the battle the body of the last of England's Saxon Kings.

Continued from page 414.

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CHEMISTRY.—VIII

The Purification of Water. — Water, we know, is volatile, but the impurities in it are mostly fixed: hence if the water be distilled the impurities remain behind.

Experiment XXV. — *To purify water by distillation.*

The apparatus consists of a flask, into which the water is put, and a simple delivery tube connecting it to a Liebig condenser. This is a long straight narrow tube, surrounded by a wider tube or jacket, through which cold water circulates upwards. The condensed steam, i.e. purified water, drips into a flask or other vessel, called the "receiver."

Instead of an ordinary flask, a special "distilling flask" may be used. This is a round-bottomed flask with a long narrow neck, upon which a side tube, inclined downwards, is blown. The cork in the neck very often carries a thermometer, that the temperature of the vapour may be known. On the large scale the flask is discarded in favour of a large copper vessel, called a "still," and in place of the Liebig condenser, a coil of metal, usually tin, immersed in cold water, is usually used. In order that the heat in the water of the condenser should not be lost, the warm water is passed back into the still.

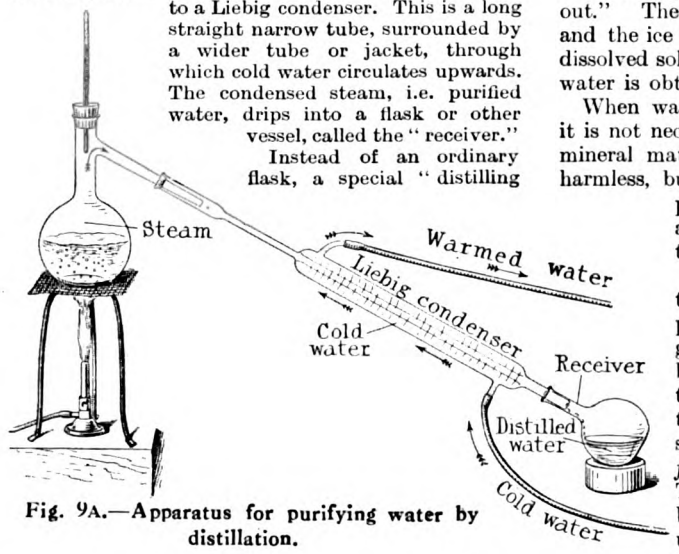


Fig. 9A.—Apparatus for purifying water by distillation.

As glass is attacked to a small extent by steam, an apparatus made of silver or tin must be employed if pure distilled water is required.

Distillation removes all the non-volatile dissolved solids, all the "suspended" solids, and most of the dissolved gases. On account of the heat required, the process is a costly one, especially if no use is made of the heat left in the purified water, or in the water used for cooling.

In very cold climates, e.g. in Russia, water is sometimes purified by the method called "freezing out." The sea or other natural water is frozen, and the ice which separates is practically devoid of dissolved solids: hence if the ice be melted, purified water is obtained.

When water is intended for drinking purposes, it is not necessary to remove from it the dissolved mineral matter, because this is, as a rule, quite harmless, but it is important to free it from suspended solids which render it cloudy, and it is still more important to eliminate the microbes which dwell in it.

Suspended solids are removed by filtration, and in the household or on campaign the addition of a pinch of alum goes a long way to clarify the water; but it must be remembered that clarification and purification are by no means the same, virulent disease-germs—the so-called pathogenic bacteria—are the *fons et origo mali* in most polluted water. The safest way to kill such germs is to boil the water vigorously for some minutes. When this is not practicable, a filter must be used.

Many of the filters in daily household use are worse than useless. Carbon, particularly when finely divided, possesses the valuable property of absorbing gases in its pores, consequently it will remove noxious gases, like sewer gas, which may be present in water, the gas being oxidised or burnt up by the oxygen absorbed by the charcoal from the air. Bone-black or animal charcoal is far more efficient in this respect than wood charcoal. Unfortunately, charcoal does not effectually stop

microbes; these collect on it, increase and multiply with a fertilify almost beyond imagination, so that fresh water put in a charcoal filter is far more likely to be further polluted than purified. If a charcoal filter is to be of any service at all, the carbon must be frequently removed and baked in an oven at a high temperature.

Practically the only household filters which are efficient are those of the Pasteur-Chamberland type. The essential part of this filter consists of a cylinder of unglazed porcelain, a so-called "bougie" or "candle." Water can pass through the pores of this medium, but not bacteria, which are deposited on it. In course of time the bougie becomes choked; it must then be removed, scrubbed, and baked.

On the large scale at municipal waterworks the water is given a preliminary purification by passing it through a filter-bed of sand or sand and gravel. When the sand is fresh it is comparatively ineffective, but after it has been in use for a few days a green slimy growth forms upon it which arrests the passage of bacteria in a surprising manner. Such sand-filters, when properly looked after, are very effective. It is not uncommon to find that a spring water, prior to being filtered, contains 200 or more bacteria per cubic centimetre; after filtration the number is reduced to less than 10. Various other means of purifying municipal water supplies are now practised, among which the application of ozone, a modification of oxygen, and of chlorine are the most effective.

Solubility and Crystallisation.—To find out if a given substance is soluble in water, a little of it should be shaken up with an excess of distilled water in a test-tube. If the substance disappears, so that a clear liquid is obtained, there is no doubt about its solubility; but if a cloudy liquid is formed, the question can only be answered by filtering it and evaporating some or all of the clear liquid which runs through—the "filtrate"—to dryness. The amount, if any, of residue will give a rough indication of the degree of solubility. For exact work it is necessary to give the term "solubility" a quantitative signification. "The solubility of a substance in water at a given temperature is the weight of it which is dissolved by 100 grams of water at that temperature."

Experiment XXVI.—*Find out if any of the following substances dissolve in water:—*

Alum, gypsum, chalk, lime, clay, French chalk, borax, tea, coffee.

Experiment XXVII.—*To find the solubility of potassium chlorate in water at the temperature of the laboratory.*

A few grams of potassium chlorate, preferably powdered, are shaken up for about five minutes with distilled water in a test-tube. When the undissolved substance has completely settled, the temperature of the solution is taken, and about 10 c.c. of it are carefully poured out into a weighed evaporating dish. The weight of the solution and the dish together is then taken.

The saturated solution is evaporated to dryness in such a manner that there is no loss due to spirting; finally, the dish may be put in an oven or the separated chlorate heated over the gas flame. After cooling the dish is weighed again.

(2) Weight of dish and chlorate solution	17·246 g.
(1) Weight of dish alone	10·018 g.
Weight of solution	7·228 g.
(3) Weight of dish and potassium chlorate	10·398 g.
(1) Weight of dish alone	10·017 g.
Weight of potassium chlorate ..	0·381 g.

Weight of water which dissolved the chlorate = 7·229 − 0·370 = 6·847 g.

Hence 6·847 g. of water dissolved 0·381 g. of chlorate

$$\therefore \text{ 100 g. of water dissolve } \frac{100 \times 0{\cdot}381}{6{\cdot}847} = 5{\cdot}56 \text{ g.}$$

In a similar way, the solubility of other substances, e.g. nitre, salt and potassium chloride, may be determined. The student is also advised, in at least one case, to find the solubility of a substance at different temperatures, and so obtain first-hand evidence of the statement that the solubility of solids in water increases with rise in temperature.

The solution of potassium chlorate obtained in the last experiment was "saturated," i.e. the water was incapable of dissolving more chlorate at the existing temperature. Supposing now the liquid were warmed, more chlorate would go into solution, and if the hot saturated liquid so obtained were cooled, the excess of dissolved substance would separate out in the form of crystals.

Experiment XXVIII.—*To crystallise potassium chlorate, nitre, alum, and copper sulphate.*

In each case a hot, strong solution of the substance is made in a test-tube and then poured into a watch-glass. The size and shape of each kind of crystals should be noted, and, if possible, sketches made.

The student should then attempt to find the effects of quick cooling and of agitation, by stirring or shaking, upon the growth of crystals. He will find that both of these operations cause rapid crystallisation, but when crystals form quickly they are very small and often distorted. Large, well-shapen crystals can be "grown" by suspending a small one of good shape from a thread in a saturated solution of the same substance. The temperature must be kept constant: if it rises the growing crystal will dissolve: if it falls a number of tiny crystals will separate out on the suspended one.

The liquid from which crystals are deposited is called the "*mother liquor.*" As this may contain impurities, it should be washed off with a very little water. The crystals are then either "air-dried" by exposing them to the air on filter-paper, or, if they are not affected by heat, they may be dried in an oven.

Another method of crystallisation, applicable only to crystals which are not decomposed by heat, is to melt the substance and allow the liquid to cool very slowly. Crystals of salt, sulphur, and of various metals can be made in this way.

Observation of crystals in general shows that they are characterised by regularity of shape, and that the corresponding angles of crystals of the same substance are always equal, and the corresponding edges parallel. It is true that some or all of the facets may be distorted, one being enlarged at the

expense of another, but the angles remain constant. Further, many crystals exhibit one or more "planes of cleavage," i.e. they can be split or cleaved more easily in one or more directions than in another or others. Thus, a cubical crystal of rock-salt breaks up into smaller cubes, as it possesses six planes of cleavage, parallel to its six facets.

Crystallisation is an operation very frequently employed for the purification of solid substances. Two substances can only be separated easily by this process if they possess markedly different degrees of solubility. On dissolving the mixture in the correct quantity of solvent and on cooling or allowing to stand, the less soluble constituent always crystallises out first.

Experiment XXIX.—*To purify potassium chlorate from potassium chloride by fractional crystallisation.*

About 5 grams or more of the mixture is dissolved in such a quantity of hot water that on cooling the chlorate crystallises out, leaving the greater part of the chloride still in solution. As a little chloride will separate out with the chlorate, the latter should be washed on the filter with a very little water, and then redissolved in pure water and recrystallised.

If perfectly pure chlorate be required, this process must be repeated more than once. A complete purification cannot be effected by one crystallisation.

Water is the solvent most commonly used in inorganic chemistry, but for organic substances alcohol, ether, benzene and such-like solvents are more often employed. E. H. T.

HEAT.—VII

32. Fusion.—As we have learned, most solids when sufficiently heated turn into the liquid form, absorbing heat as they do so: this process is called *fusion* or *melting*. Some solids, like ice, melt sharply at a definite temperature known as the melting-point of the solid. A block of ice, when heated, rises in temperature up to 0°, and not till this point is reached does it show any sign of melting. It

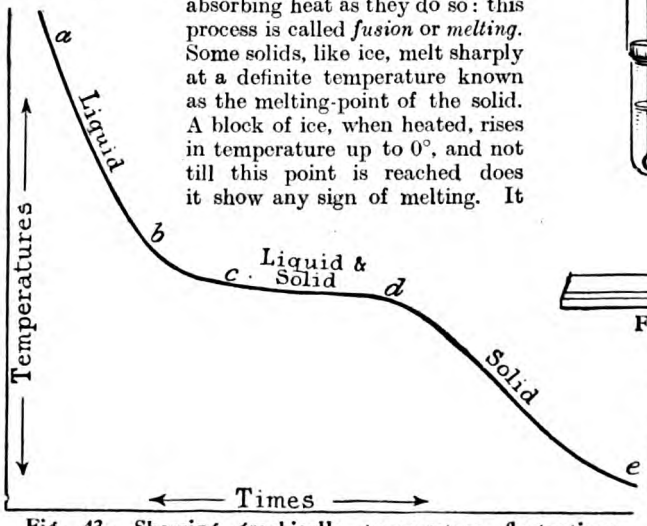


Fig. 43.—Showing graphically temperature fluctuations during transition from liquid to solid.

then begins to melt on the surface first, but its temperature makes no further rise until it is all melted. Some solids, however, do not show this sharp transition; they begin to soften, and become plastic long before they can be said to be liquid. Sealing-wax, glass and iron behave in this manner, and it is owing to such behaviour that iron can be moulded and welded easily. Nevertheless, even in these cases, there is a temperature at which a specially large absorption of heat occurs, which temperature can be regarded as their melting-point. Moreover, the plastic stage probably exists in the other class of substances; ice itself, especially under pressure, seems to behave like a plastic solid near to its melting-point.

In order to determine the melting-point of a substance like wax, draw out a piece of glass tubing to a fine point (Fig. 45); close the narrow end, and put into the tube some small pieces of the wax. Then place the tube in boiling water, until the wax melts and runs down into the fine portion of the tube. Tie the tube to a thermometer, and again melt the wax as before. Note carefully the temperature at which the wax first appears to solidify. When all is solid, place the tube and thermometer in a beaker of cold water; heat the water, with constant stirring, until the wax begins to look clear, and again read the thermometer. If this reading differs slightly from the previous one, the average of the two may be taken as the melting point of the wax.

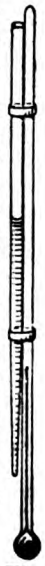


Fig. 45.

Another method, more tedious to carry out, but very instructive to the student, should also be tried. About half-fill a test-tube with the wax; heat it considerably above its melting-point; then insert a thermometer through a cork (Fig. 44), so that it is buried in the wax above the 20th degree at least. Hang the tube on a stand, and note the temperature of the melted wax at intervals of half a minute until some minutes after it has all become solid. The results obtained should be plotted on squared paper, the horizontal measurements representing times and the vertical ones the temperatures of the wax corresponding to them. A curve will be obtained something like that shown in Fig. 43.

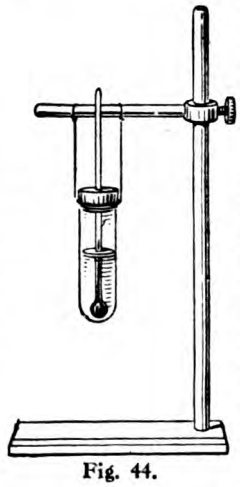


Fig. 44.

This curve shows three distinct parts: (1) the steep part *a b*, representing the rapid cooling of the liquid wax; (2) the almost horizontal part *c d*, representing the period when solidification takes place, which therefore gives the melting-point; and (3) the sloping part *d e*, representing the cooling of the solid wax—not so steep as (1) because the wax is now colder and therefore cools more slowly. It is to the second part *c d* that we must give especial and careful thought. During the time represented by it, the wax did not cease to give out heat, though it ceased to fall in temperature; the heat it was losing made no difference to the temperature; hence, it was the

latent heat, required to melt the solid wax, but now given back as the liquid returns to the solid state. Therefore, *c*—or the average of *c* and *d*, if *c d* is not quite horizontal—gives us the melting-point of the solid. Between *b* and *c*, and immediately after *d*, there are transition portions of the curve, corresponding to the doubtful stage, when the substance seems to be neither true solid nor true liquid—a stage which may be prolonged if the solid goes through an evident plastic state.

33. Change of Volume on Fusion.—As a liquid is cooled towards its freezing point, it contracts little by little, and the process of contraction is in most cases continued as the liquid passes into the solid state—the solid occupying a smaller volume than the liquid from which it is formed. This may be tested in the case of wax, for instance, by filling a small test-tube quite full with liquid wax, and then allowing it to cool. The solid wax does not then fill the tube.

Important exceptions to this rule exist, however. Some metals, like iron and the alloy used for casting types, expand at the moment of solidification, which enables sharply-defined castings to be obtained with those metals. More familiar is the case of ice, which occupies a volume about 9 to 10 per cent. greater than the water at 0° from which it has been formed. Water, as we know, expands as it is cooled from 4° to 0°; but the expansion that occurs on freezing is comparatively large, and takes place *suddenly* at the moment of freezing. It also takes place with great force, *e.g.* our burst water-pipes in winter time. The increase can easily be observed if a tinful of water is put out of doors on a frosty night, when the ice will be seen to overflow the tin. An obvious result of this expansion is that ice is lighter than water, and therefore floats on its surface. This fact has an important bearing on the climate of temperate countries; owing to the high heat capacity of water, ice would remain permanently unmelted at the bottom of ponds and lakes, if it were heavier than water.

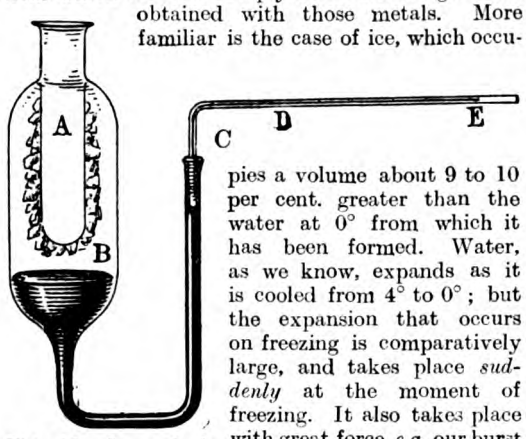


Fig. 46.—Ice calorimeter.

In order to measure the relation between the volume of ice and that of the water formed from it, take a 250 c.c. measuring-jar, pour into it about 150 c.c. of water, and then add a few pieces of dry ice, which are to be sunk by means of a stone whose volume has been previously found. From the rise of the water in the jar, we can easily find the volume of the ice. Let the jar stand in a warm place till all the ice is melted, and again read carefully the level of the water; it will be found to have *fallen* an amount dependent on the amount of ice added, thus showing that the ice occupied a larger space than the water produced from it (Fig. 47).

Volume of sinker = 35 c.c.
Volume of water in jar at first = 150 c.c.
Reading of jar when ice and sinker have been added = 240 c.c.
∴ Volume of ice added = 240 − 150 − 35 = 55 c.c.
Reading of jar after ice has been melted = 235 c.c.
∴ Volume of water produced from ice = 235 − 150 − 35 = 50 c.c.
Hence 55 c.c. ice produce 50 c.c. water.
And density of ice = $\frac{50}{55}$ = 0.091.

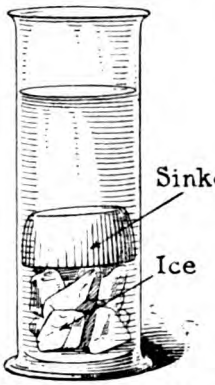


Fig. 47.—Apparatus to show change of volume on fusion.

This quantity, which measures the expansion of water on freezing, can be measured with great accuracy by more delicate apparatus; and in *Bunsen's Ice Calorimeter* it is used to determine specific heats. That instrument is not easy to use, but its construction may be briefly described.

A (Fig. 46) is a glass vessel, about the size and shape of a test-tube, fused into the glass tube B, as shown in the figure. B is bent twice at right angles, and connected with a bent tube C D E of rather wide capillary bore. When the instrument is ready for use, B contains mercury (darkly shaded in the figure), and water which has been well boiled to get rid of dissolved gases. No air must be enclosed in B, and the attainment of this point is the main difficulty in manipulating the instrument. A little cooled ether is poured into A, and a current of air blown through it. The evaporation of the ether produces enough cold to freeze some of the water in B, and hence to push the mercury along to E, we suppose. If now some water which has been cooled to 0° is placed in A, and the whole of A and B placed in melting-ice, the ice in B cannot be melted and E will maintain a fixed position which can be noted.

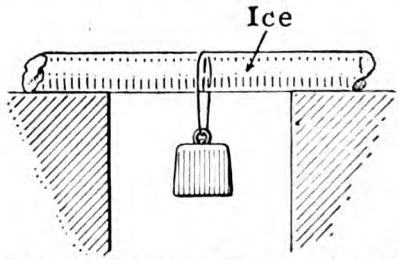


Fig. 48.—Demonstrating the effect of pressure upon ice.

The hot metal is then transferred to the water in A, and left there till it is cooled to 0°. In thus cooling it will at first warm the water in A, but this water will again part with its heat to the ice in B. Some of this will be melted, and, occupying smaller space, will cause the mercury to move along the tube to D. When metal and water in A have fallen

to 0°, D will be stationary, and the length of D E can be carefully measured. On removing the tube, we can find the volume of mercury which corresponds to the length D E, from which we can find the volume of ice melted. From this we can calculate the amount of heat given up by the metal in falling from $t°$ to 0°, $t°$ being the temperature to which it was heated.

From our previous example we learned that
11 cc. of ice change into 10 cc. (= 10 gr.) of water, and lose 1 cc.
If DE = v, ∴ weight of ice melted = 10 v.
∴ Amount of heat produced = 10 v × 79.2 calories.

34. Effect of Pressure on the Melting Point.—It might be supposed on general grounds that pressure would have an influence on melting; for, if a liquid expand on freezing, the effect of pressure would be to tend to prevent the expansion and so delay the freezing, in other words pressure would tend to lower the freezing-point of such liquids; and vice versa to raise the freezing-point of those liquids which contract as they solidify. This is found experimentally to be the case, but only to a small degree. In the case of ice, however, the effect is important enough to deserve consideration.

If two pieces of ice are pressed firmly together, they freeze into one mass—with especial ease if they are held under water. The pressure causes the melting-point to be depressed; hence at 0°, those parts of the ice which are subject to the pressure will melt; and as this releases the pressure at those points, the water formed will freeze again and unite the two pieces of ice in one. Precisely the same thing will take place when a snowball is pressed hard in the hand, if the snow is not far removed from 0°. This last condition is necessary, because the pressure exerted by the hand could not reduce the melting-point to —10°, say. The formation of a good slide in snow is dependent upon the same conditions.

The effect of pressure upon ice may be clearly shown in the following experiment: Support a block of ice firmly on two supports (Fig. 48), and throw round it a loop of copper wire which carries a weight of about 14 lb. The wire will then be seen to cut its way through the ice, till the weight falls on the table; but the ice will remain whole. The wire, exerting pressure on the ice, causes some of it to melt; it will then fall on to another portion of the ice, while the water formed, having been relieved of the pressure, freezes again. It is thus that the wire cuts its way through, the ice melting and refreezing as it passes. The whole phenomenon is often spoken of as *Regelation*.

The movement of glaciers has often been explained by reference to regelation, and no doubt this plays an important part in causing the motion. The pressure of the overlying ice in a glacier-bed is very considerable, and might well cause a melting at points, such as irregularities in the bed, where it may be brought to bear. But, inasmuch as regelation cannot take place much below 0°, that is probably not the only cause at work. The strain and tension to which the ice is subject will produce many cracks and crevices, and the broken pieces may become fused again by regelation, which thus helps to keep the glacier continuous. Others have thought that ice near 0° is a plastic substance and that this would account for the river-like motion of glaciers; but there is no real evidence of this, and truly plastic solids like sealing-wax do not submit to regelation. The real difficulty is to picture the internal condition of the ice under pressure. Ordinarily it is an irregular mass of crystals, and possibly a sort of order is induced in the mass by great pressures.

35. Solutions.—Many solid substances dissolve in water or other liquids, and in so doing evidently pass into a condition akin to the liquid. But if the solid melts, latent heat will be necessary; and unless this is supplied from without, it will be drawn from the liquid itself, which will consequently become cooled. This cooling may be very well observed when ammonium nitrate is dissolved in water; but it is masked in those cases in which chemical action takes place, producing heat, as when caustic soda dissolves in water.

When a solution contains as much substance dissolved as can be dissolved at the temperature of the liquid, it is said to be *saturated*. In general, a saturated solution at 100° contains more substance dissolved than it would have at 0°. Hence a solution saturated at 100° will, when cooled, deposit some of the dissolved substance in the solid form; in doing so it will give up the latent heat which was used in the original act of solution, and the liquid will become hot. This fact can be illustrated with either sulphate or acetate of soda.

Take a perfectly clean flask, three-quarters full of distilled water, and add, little by little, sulphate of soda (Glauber's salt) until the water will dissolve no more, even when heated to 50°. You will then have a solution of the salt saturated at 50°. Let the solution now stand and cool slowly without disturbance. If you are careful not to shake the flask, the solution may be cooled to 10° without depositing any salt. But in this condition it is evidently over-saturated with the salt at that temperature, and this is an unstable condition. Hence when a tiny crystal of the salt is dropped into the solution, the liquid immediately becomes a solid mass of crystals, with evolution of heat.

This phenomenon of supersaturation, which renders the last experiment especially striking, is very similar to the "super-cooling" which often occurs in ordinary fusion. Water, well boiled and perfectly pure, may be kept in clean vessels two or three degrees below 0° without freezing, though a little shake, or a particle of ice dropped in, will cause the whole mass to freeze and its temperature to rise to 0°. With a little care water may be taken to —6° C. without freezing. Super-cooling is often observed in jugs of water if they are left quiet and still in cold rooms: the ice is formed as soon as the jug is moved.

We have to add here that the presence of a substance dissolved in a liquid always lowers the freezing-point of the liquid. The familiar case of ice and salt will occur to everyone. A strong solution of salt does not freeze till 0° F. or —18° C. The addition of salt to snow is a sure way to melt it, but the unpleasantly low temperature produced in the process is as disagreeable as the snow itself. E. W. E.

ZOOLOGY.—VIII

ALL the carnivora have claws, but in none of the dog tribe can these be protruded or retracted from or into sheaths, as in the case of the cats. When walking the cat, whatever its name, keeps its claws completely hidden within their sheaths; but when it pounces upon its prey and strikes, the claws are automatically protruded and thrust like grapnels into the flesh.

The one exception to the rule occurs in an animal which is neither cat nor dog,

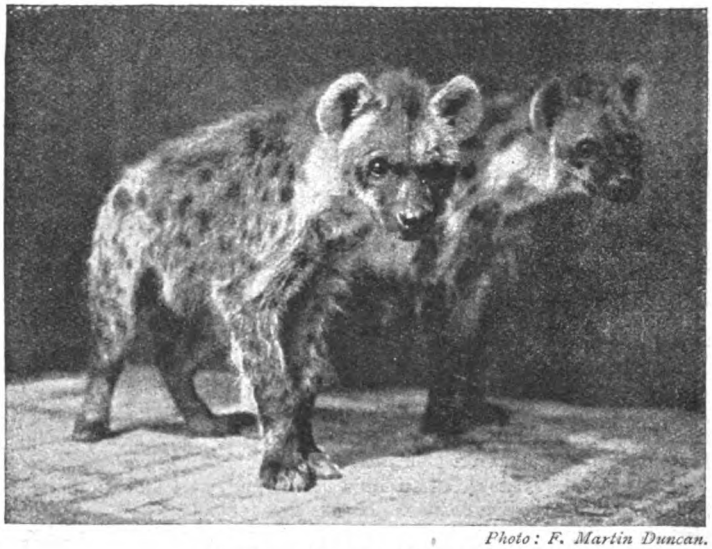


Photo: F. Martin Duncan.

YOUNG SOMALI HYENAS.

Flock rearing in Africa is still enormously hampered by the activities of these animals.

and that is the so-called hunting-leopard, whose correct name is cheetah. Fashioned like a long-legged leopard, this animal resembles the dog in certain internal features, but it purrs like a cat; its habits are precisely those of the tiger and leopard, yet its claws are immovable, or practically so, like those of the dog.

When attacking, lions and tigers do not leap through the air upon their victims, but keep to the ground in their rush until the last moment. In the case of a man they may charge straight at him and knock him over, but with a large animal they rear at the right moment, seize it with its paws—one on the back, one under the neck—bite into the back of the neck as already stated, and hold by means of the terrible claws, until instantly the force of the collision breaks the stricken animal's neck; whereupon the second bite is to the throat, whence a deep draught of blood is drawn.

The cheetah, reputed to be for 500 yards the fleetest creature on four legs, cannot use claws as a weapon. Like a dog or wolf or hyena, it must seize with the teeth. What Mr. Roosevelt used to call the "jugular instinct" is practically infallible, and the cheetah strikes home fatally at the first bite. This animal, save the domestic puss, is the only one of the cats wooed to the service of man. In India it is trained to hunt deer and other animals. It is carted, hooded like a falcon, to the scene of the hunting, released when game is sighted; kills, drinks deep with eyes closed, and at that moment is hooded afresh and, after a reward in kind, is taken back to its conveyance.

Tiger Ferocity

Teeth, claws, and cunning have brought the cats to their present pre-eminence in the animal world, and claws play an important part. The singular thing is that lions and tigers, although agile enough in scrambling among rocks, cannot climb trees. All the other cats are highly expert in this direction, and the jaguar and leopard are as much at home in the trees as on the ground, a fact making them almost more to be feared than their larger cousins, from the fact that their attack may come either from overhead or from the level of their victims. But there is this difference between lion and tiger, and leopard and jaguar, that whereas the two former animals become man-eaters only by a sinister sort of conversion, the other two kill human beings, as soon as they are able.

The danger to humanity from the lion in India has vanished, for the animal has practically disappeared from the Dependency, though the tiger abounds there. The lion is supposed not to attack men until it becomes too old and slow of movement to overtake deer or kill cattle, and the same theory holds as to the tiger. With regard to this latter beast there is a more certain foundation upon which to work, for the evidence available is more ample.

There seems no doubt that a tiger which

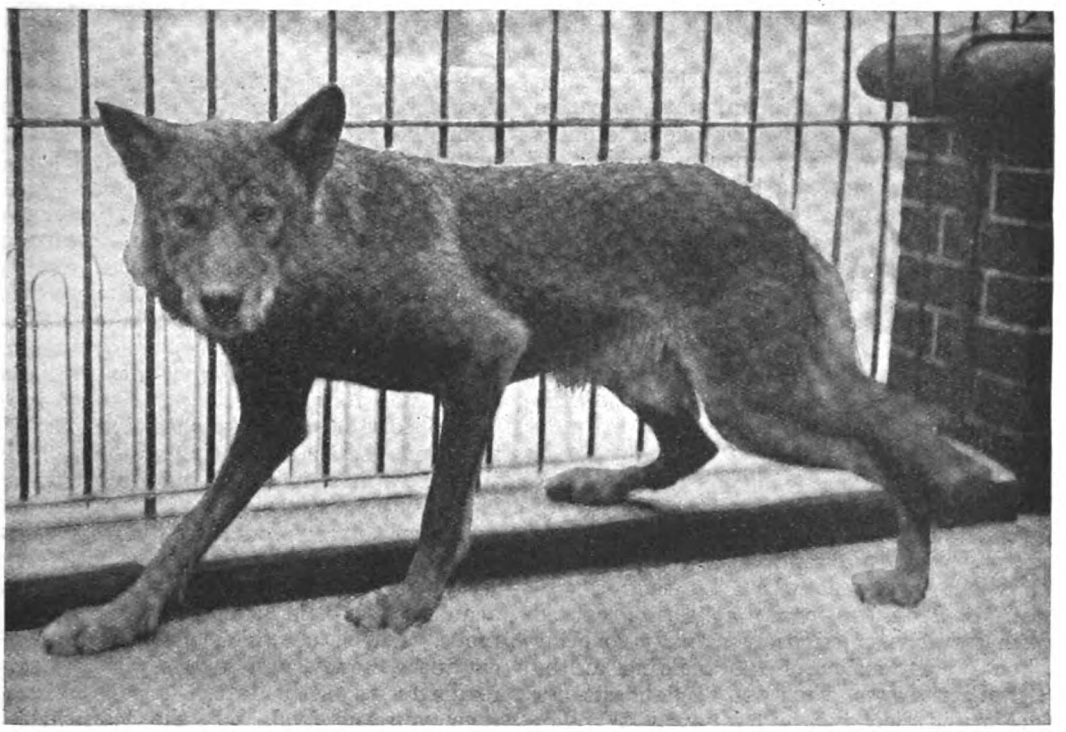


Photo: F. Martin Duncan.

SIBERIAN WOLF.

Unlike the bear, in his northern range, who passes the winter in sleep, the wolf must keep on the move.

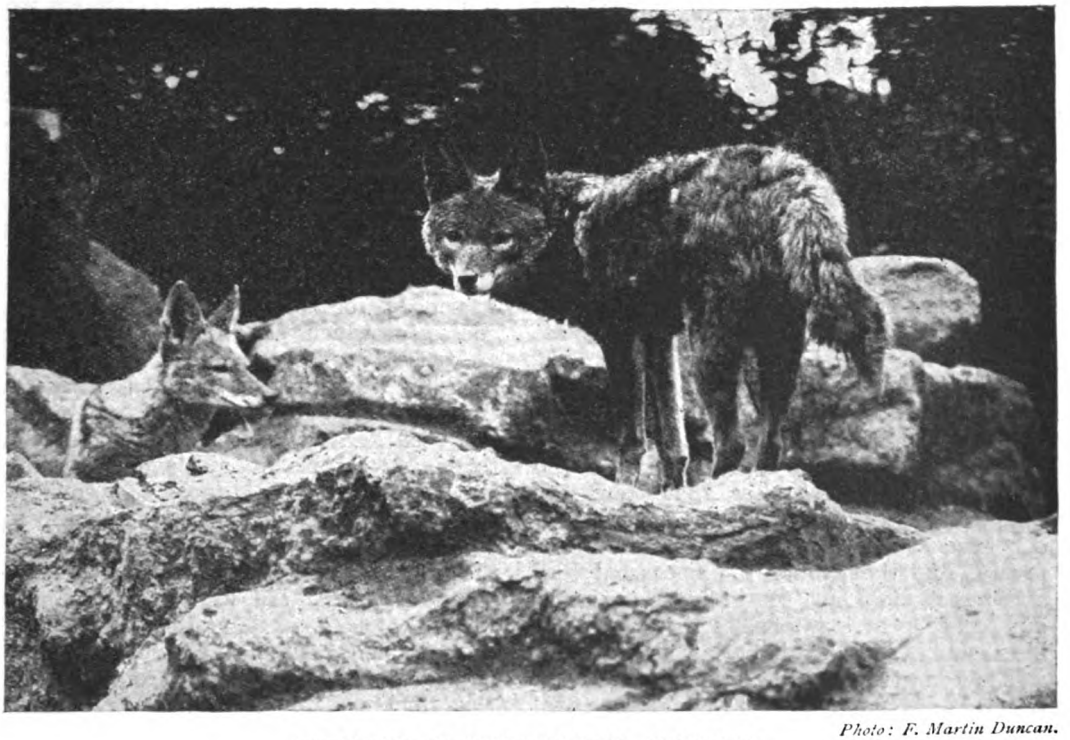


Photo: F. Martin Duncan.

AFRICAN BLACK-LEGGED JACKALS.

In common with the domestic dog, the jackal has ten teeth on each side of the upper jaw, and eleven on each side of the lower.

has been wont to prey upon herds retains an instinctive fear of man, until a native some day seeks to drive his enemy from a threatened steer. The innate ferocity of the tiger overcomes its hesitancy to attack man; it does attack, and easily kills, and from that time becomes a man-eater. The spell is broken; the long-dreaded guardian of the herd proves more feeble than his animals, and the tiger will seek out men, women, and children in preference to animals, till villages are half depopulated by its ravages, and the remainder of the natives flee the area in terror.

Man-eaters

A similar process of evil evolution of habit is ascribed to the lion, but there is no rule without exception, and it is certain that the two lions which by their depredations upon the camp at Tsava caused such a season of terror as actually to bring about a suspension of the building of the Uganda railways, were not aged beasts nor lacking in fleetness and power. Whether they were already man-killers before attaching themselves to the purlieus of the railway cannot be known, but it was men whom they sought as meals, ignoring the flocks of sheep and goats collected in the neighbourhood. Every art to trap and slay them was for long set at naught; they avoided the traps, they slew men lying in wait for them. Every visit they paid at night to the camp cost a human life. During nine months they killed and ate twenty-eight Indian coolies in Government pay, in addition to scores of African natives, of whom it was impossible to keep official record.

The cats are mainly nocturnal in their habits, and the supposition is that they see better in the dark than in the light. This, of course, is not the case. No animal sees in absolute darkness. Animals whose lives are passed in caves become sightless; the eyes of certain moles have atrophied and become as functionless as that third eye which we once possessed on the tops of our heads. The eye of the nocturnal carnivore, like the eye of the nocturnal bird and insect, does not see in utter darkness, but collects and intensifies rays of such illumination as is available at night.

The extraordinary brightness of the eye of a cat in the relative blackness of night arises, not from the creation of light in this organ of the animal, but from the concentration of the light-rays received, concentrated and thrown back by the crystalline lens at the rear of the eye. The belief is that this reflection of the rays back again from the tapetum gives the eye what is tentatively called a second impression.

Sight is reinforced in the cats by the presence about the muzzle of numerous long bristle-like hairs, which, connected with highly sensitive nerves, act as "feelers," as it were, delicate organs of perception which serve as guides to the animal when, with head down, it is creeping or charging through the gloom of its haunt, with eyes fixed upon its prey.

None of the cats hibernate, but, like the raccoons, bears in their northern range pass the winter in sleep, the most astonishing example extant of animals of size and substance accommodating themselves to the changing seasons of the year. Wolves, which roam as far north as bears, have not acquired this habit, but must keep on the move. Bears, of which many species will eat roots, honey, and berries with the same readiness as flesh, fatten prodigiously on their summer food, but the lean wolf is as vigilant in his winter quarters as hyena and jackal, which know no winter, but continuous plenty. The hyena is happy with the remains of a great cat's banquet, and cracks the thigh-bone of an ox with as considerable facility as a monkey cracks a nut; while the jackal has been from time immemorial the scavenger of the cities and villages which man has reared in its habitat.

Domestic Carnivora

The carnivora indeed play a larger part in human affairs than we generally recognise. Hyenas and jackals scavenge, a civet yields a coveted perfume and is tamed and "farmed" for its peculiar possession; mongooses, of which there are a dozen species, are trained to play snake-ward in the homes of white men in the tropics; otters are trained to fish for men; the domestic cat has been derived from wild Egyptian stock to be an important aid against vermin; we have evolved the domestic ferret from the wild and noxious polecat, and the tale of the dog's service to humanity is one of the romances of man's mastery of the lower creation. There are wild dogs still which we do not seek to domesticate, dogs which show immense intelligence, hunt in concert and enjoy the reward of communal life. But they are not related to our domestic dogs, nor to wolves and jackals from which our four-footed friends descend.

Domestic dogs, in common with wolves and jackals, have ten teeth on each side

of the upper jaw, and eleven on each side of the lower, whereas the wild dog has only ten teeth on each side of both upper and lower jaws. Foxes agree with wolves, jackals and domestic dogs in the number and arrangement of the teeth, but they descend from a different type of ancestors, armoured with a scaly covering resembling that of the existing pangolins. Not that the fox itself retains the scales of antiquity. The arrangement of the hair and the structure of the skin as seen in the pelts of young foxes, however, is just such as would be expected in an animal the hide of whose ancestors was once clad with a combination of scales and hair.

Armour of bones and scales, once general among many types of descendants of the old mammal-like reptiles from which true mammals have arisen, served its day, and was slowly discarded, leaving animals less protected but more alert, less dependent upon the shield of the inert, more beholden to initiative and mental agility.

Throughout the carnivorous order we find the most absorbing chapters of the story of evolution, and the common fox of our islands is an interesting example of types which survive the ages. It was a Briton before the ancient Britons. It was already one of our oldest mammalian inhabitants when the mammoth arrived, and witnessed the extinction of all the great mammals whose relics are now found only in the river gravels and contemporary deposits.

Fleetness and cunning in the fox, tough resistance and deep-delving for home in that king of the weasels, the splendid badger, cousin of the noisome skunk and of the graceful fisher of the rivers, the otter, have kept these ancients safe and numerous through all the development and extensions of civilisation into the wilds. Otters still play and prey in the rivers of the Home Counties; badgers flourish almost within London's four-mile radius. Weasels are everywhere; stoats abound close to the capital. Sea otters are menaced, and the few survivors are adapting themselves to a life like that of the seals.

But the perils of the ancient carnivorous order multiply apace. Mankind, in spite of wars, increases rapidly in numbers, and extends the bounds of his provinces at an unprecedented pace. He invades the homes of the carnivora with new weapons. He must destroy their preserves to make his own home. Local species perish from the face of the earth as forests are cleared; whole genera will vanish as science makes it possible for man to conquer mosquitoes and other winged carriers of death which now sets bounds which white settlers at present may not pass. But the fight for possession of place in the sun will be long and desperate.

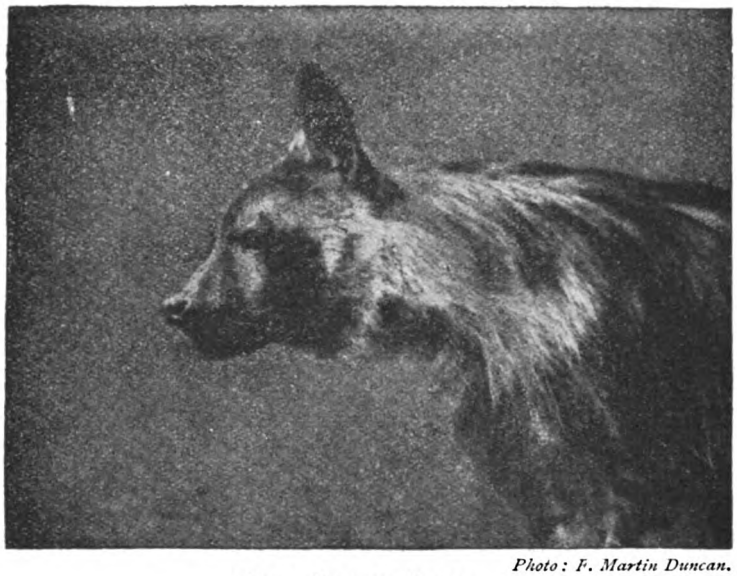


Photo: F. Martin Duncan.

GREY-MANED HYENA.

The hyena is an inveterate scavenger, and can crack the thigh-bone of an ox with the same facility that a monkey cracks a nut.

Carnivora and prosperous human settlements cannot abide together, and more and more, as man penetrates the wilds, will the age-old conflict between himself and the flesh-eating mammals become intensified.

It is deplorable that the contest should be to the death, but that which we are witnessing, whose consummation will not be achieved for generations, is but part of the whole long story. Man has had to fight for his life against the beasts from the time of his emergence. It has always been war between man and his living possessions against the flesh-eaters, and it will be war until the carnivora vanish. E. A. B.

ASTRONOMY.—VIII

THE son of a musician at the Court of Hanover at the time when the kingdoms of England and Hanover owed allegiance to King George III., Herschel was trained to follow in his father's profession, and while still a boy was engaged as a musician in the band of one of the Hanoverian regiments, which suffered severely in the campaign against the forces of Marshal d'Estrées at the opening of the Seven Years' War.

Unable to endure the hardships of the campaign, he obtained his discharge, and came to England. For some years he followed the profession of music in the north, and afterwards at Bath, where he conducted the concerts at the time when Bath was at the height of its fashion. How Herschel became interested in astronomy nobody knows, for he has left scarcely any trace of an interest in the subject until in his Journal there comes the sudden entry: "1773, April 19, bought a quadrant and Emerson's Trigonometry"; while in June of the same year he hired a two-foot reflecting telescope for three months.

Sir William Herschel

When we say a two-foot telescope, we mean, in the language of that time, a telescope two feet long, and not, as it would mean now, a telescope two feet in diameter. Probably the telescope which he hired was at the outside three inches in aperture, and he very quickly became discontented with the performance of so modest an instrument. But a telescope of about seven inches in aperture was the greatest which could have been bought at the time, and such an instrument was far beyond his means.

So Herschel resolved to make his own telescope, in which he succeeded to such a degree that in the course of a few years he had constructed an instrument of a size hardly contemplated, much less realised, before. By quick steps he arrived at the possession of a telescope twenty feet long and nearly two feet in aperture; that is to say, with an opening as great as was the length of the telescope that he had hired a few years before. With this instrument he set himself to explore the heavens, and within a few years he had contributed to the Royal Society catalogues of two thousand nebulæ and clusters of stars that were entirely new.

Herschel's crowning achievement was the construction in 1789 of a mirror four feet in diameter, mounted in a tube forty feet long, to form the instrument which is immortalised in a well-known engraving, and on the seal of the Royal Astronomical Society. By his unaided exertions he had enlarged the reflecting telescope tenfold, leaving far behind the refracting telescope, in which the image is formed by a lens instead of by a mirror.

The size of refracting telescopes was still restricted by the difficulty of obtaining glass of the required high quality, though a capital improvement had been effected by Dollond in his discovery of the way to get rid of the defect which had previously hampered the usefulness of this kind of telescope. A single lens does not produce a single image of a star, but a whole series of images one behind the other, of varying colours, so that wherever the eye-piece is placed one sees an image of the star surrounded by fringes and coloured flares.

Modern Telescopes

Even so great a man as Newton had come to the conclusion that this defect could not be got over. It was left to Dollond to discover that by making the lens compound, of two different kinds of glass with appropriate curvatures, the greater part of this defect could be overcome, and, what was equally important, the telescope could at the same time be reduced to a reasonable length.

Thus, the so-called achromatic telescope, or telescope in which the image was not disfigured by colour, was an enormous advance, whose importance unfortunately lost some of its practical advantages owing to the old difficulty of obtaining glass, so that it was not until well after the middle of the last century that the refracting telescope began to compete in size with the reflecting.

Having thus briefly traced the early history of the telescope we must pass to the telescope as it exists to-day in the principal observatories of the world. The history of the two forms has been singularly different. The professional astronomer has generally, or until quite recent years almost entirely, leaned towards the refracting telescope, which, when once made, remained in good order with little care for quite an indefinite period.

We will take as the foremost example the great telescope erected in the observatory some ninety miles from Chicago, which was given to the University of that city by the late Mr. Yerkes. The object glass is forty inches in diameter, the tube in which it is carried is sixty-three feet long, and the dome under which it is mounted is ninety feet across, or but slightly less than the inner dome of St. Paul's Cathedral.

In order to enable the observer to reach the telescope in all positions the whole floor of the observatory is made to rise and fall as an immense hydraulic lift. In order to drive the telescope, to follow the motion of the stars and to annihilate the motion of the earth, there is contained within the column of the telescope as much machinery as would drive a respectable steamboat. Every refinement of engineering has been utilised in making this splendid instrument, which has become so elaborate a piece of machinery that it is necessary to have an engineer in charge of the telescope to relieve the astronomer on duty from the anxiety and care of maintaining the complex machine in perfect running order. The cost of the whole installation is such as only a millionaire founder could defray.

From the portrait by John Russell.

SIR WILLIAM HERSCHEL (1738-1822)

was born in Hanover, came to England in 1757, was appointed Astronomer Royal in 1781. He erected his famous telescope —with a focal length of 40 feet—in 1789.

From the portrait by Johann Van der Banck.

SIR ISAAC NEWTON (1642-1727),

the English philosopher who, from observing the fall of an apple (a well authenticated story), evolved the law of gravitation, was an ardent astronomer, and constructed, in 1668, the first reflecting telescope. (*See p.* 414)

There are many interesting problems attaching to the performance of such an instrument. With every increase in size comes the question whether the limit of possible construction has been reached. Will the glass be able to support its own weight without bending and destroying its figure? Can the tube be made so stiff that it will support without flexure the great weight of the lens? When the whole weight of the moving parts of the telescope runs into tons, is it possible to balance it so exactly, and to mount it in bearings of such perfection, that it can be driven with perfect smoothness to follow the motions of the stars, so that the fine spider web in the micrometer of the eye-piece can be kept at will precisely set upon a star in the field of view?

The answer to these questions is briefly this: that we have not reached as yet the limit of the mechanical possibilities; but we have reached for the moment, and indeed overpassed, the possibility of making the discs of optical glass. It is a lamentable fact that were another Mr. Yerkes to order another Yerkes telescope, the order could not at present be executed. There is a great secret in glass-making which seems to have been lost. There have never been more than one or two firms in possession of it. Glasses for lenses of so great a size has and will always be very difficult to obtain.

In other respects there would seem to be no difficulty in surpassing the dimensions of this telescope. But it must always be remembered that the cost of a telescope rises out of all proportion to its size; while the cost of the accessories, the dome and the rising floor, increase as fast, or even faster.

Giant Reflectors

Eventually one reaches a point at which the cost of the dome and the floor become greater than the cost of the telescope, and it may very well be doubted whether it is worth while to go much farther.

However that may be, recent efforts to construct very large instruments have been directed to the construction of reflectors. No one has yet surpassed in size the six-foot reflector that the Earl of Rosse mounted at Parsonstown, in Ireland, about the middle of the last century. But there is in the optical shops of the Solar Observatory on Mount Wilson in California a disc of glass a hundred inches in diameter which is gradually being fashioned into a mirror bidding fair to beat all previous records for size. And for some years there has been in operation at that observatory a reflecting telescope of sixty inches aperture, which, although smaller than Lord Rosse's, is unquestionably of greater power, because of the much greater perfection of its mounting.

For a long while it was considered that it would not prove possible for the reflecting telescope to be mounted with so great a degree of refinement as a refractor, and there is no doubt that this view arose largely from the circumstance that the construction and use of reflectors was so largely in the hands of amateurs, who arrived at great skill in the process of making the mirrors, but had not the means or the skill to make the mounting correspondingly good.

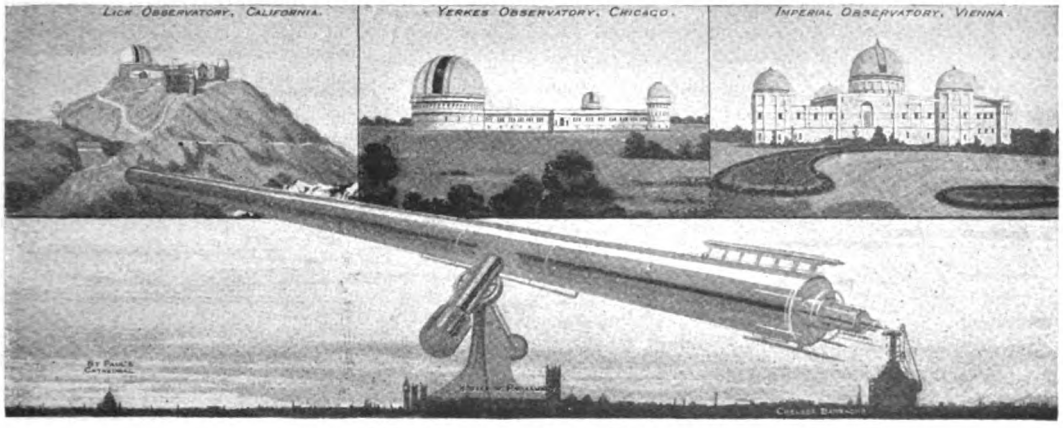
It was the late Dr. Common who, about 1875, turned his great mechanical genius to the improvement of the reflector as an instrument of precision, and who showed that there was no real reason why a reflector should not be mounted in a refined way, in spite of the fact that there are peculiar difficulties in supporting a large mirror so that it will not bend and spoil its figure. Dr. Common's work has been continued and extended by several first-rate constructors, particularly by Mr. G. W. Ritchey, who was optician successively to the Yerkes Observatory and to the Solar Observatory on Mount Wilson. In his hands the mounting of the reflector has reached an astonishing degree of precision, as is shown by the high quality of the photographs which he has produced.

It will at this point be interesting to consider a little more closely the way in which the mirror of a reflecting telescope is made, for the process of manufacture is well within the scope of the skilful amateur. All modern mirrors are made of glass, silvered on the surface, and they have a notable advantage over the old-fashioned metal mirrors, which were made of a hard and intractable alloy of copper and tin, known as speculum metal. It is a fine, hard metal which takes a good polish, but it has the disadvantage that when the surface gets tarnished all the delicate work of refiguring the mirror must be done over again.

How Mirrors Are Made

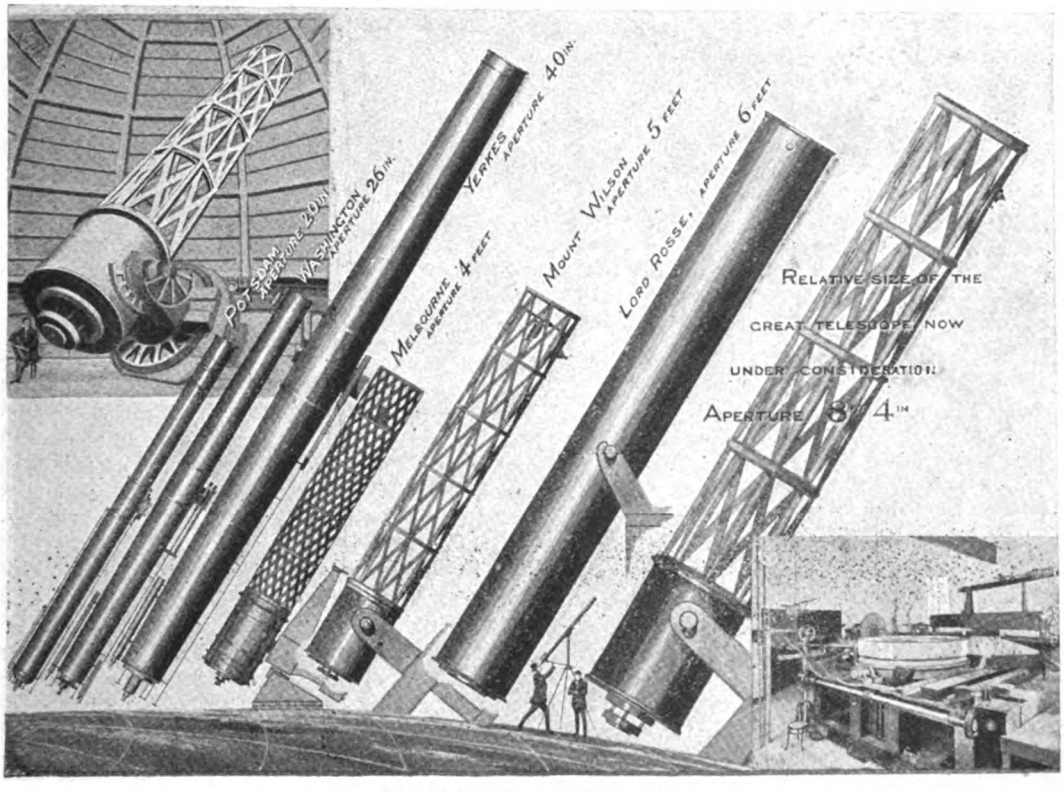
The silver on glass reflector has no such disadvantage. When once a good figure has been given to the glass the mirror is practically everlasting. When a silver film becomes tarnished it can be dissolved off with acid and a new film deposited; the polishing of a silver film only two hundred and fifty thousandth of an inch thick does not seem in any way to alter the figure of the glass beneath it. This is an immense advantage in practice. The figure to be given to the glass is a paraboloid of revolution whose section is a parabola. But this figure is not at once arrived at. The first process is to give the mirror a spherical surface, which is done with iron grinding tools cast to the requisite curvature and turned up in a lathe. Small mirrors may be ground by hand. Herschel, indeed, found that it was possible to deal in this way with mirrors two feet in diameter, but it is probable that few will be so bold as to follow his example. It is, however, quite possible to work a mirror up to about fifteen inches in diameter by hand.

The glass is ground with successively finer grades of emery introduced between the glass and the tool, and is first brought to a spherical



THE ASTRONOMER'S DREAM.

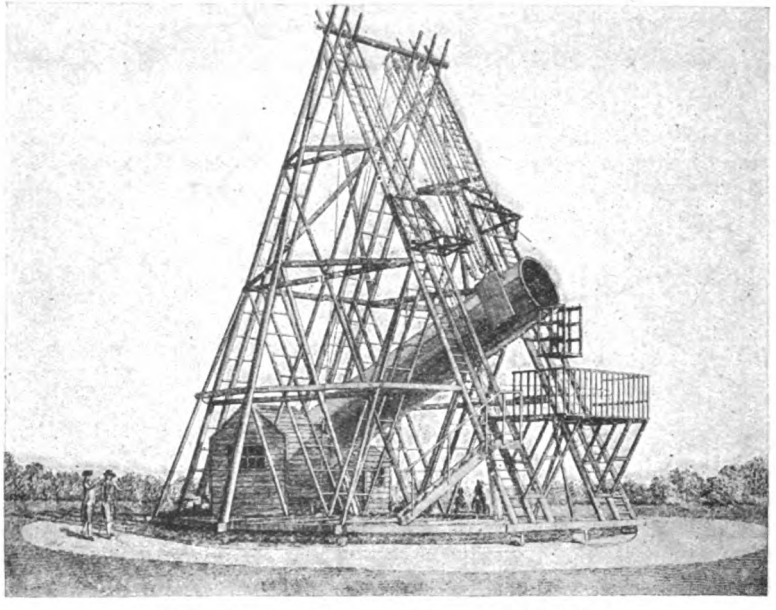
A giant telescope, three miles long—extending, that is to say, from Chelsea Barracks, London, to St. Paul's Cathedral—alone would be sufficiently powerful to determine the more intimate secrets of the heavens, and until it is constructed such questions as "Is there Life on Mars?" cannot be answered.



ASTRONOMICAL REALITIES.

Relative dimensions of some of the world's largest telescopes. On the right is shown the giant telescope which an ambitious Californian astronomer, Professor Ritchey, has designed and which he hopes will reveal objects on the Moon the size of a man. Inset are figures of this telescope as it would appear when mounted, and of the lens on the grinding table.

surface, when it is polished with a tool of pitch and rouge to allow of testing by reflected light. When the maker is satisfied that he has obtained a perfect spherical figure he has next to make an extremely slight change to the parabolic form : a change which, expressed in inches, is scarcely anything, but which makes just all the difference in the quality of the image. The curious thing is that this change is effected merely by altering the stroke of the same polishing tool which produced the spherical surface.



HERSCHEL'S CROWNING ACHIEVEMENT
was the construction, at Slough, in 1789, of a mirror 4 feet in diameter mounted in a tube 40 feet long—the greatest telescope that as yet had been produced.

From time to time the mirror is set up on edge, and tested by one or other of the optical processes which have been evolved. The larger errors are removed with certainty, but, as in all fine operations of craftsmanship, it is almost impossible to explain exactly what the man does to obtain the last degrees of perfection. By continual trial and experience he gains a mastery over the tool and materials which he can hardly explain to another, though there is, of course, much to be learned from the study of such a work as *The Modern Reflecting Telescope* by G. W. Ritchey (Smithsonian Contributions to Knowledge, Vol. 34), in which the author has given by far the most complete and interesting account of the whole process which has ever been published.

While many amateurs have made reflecting telescopes there is, so far as the writer knows, only one who has been successful in making a refracting telescope, which is a great deal more difficult : partly because there are many more surfaces to be figured, partly because the optical tests are more difficult to carry out, and perhaps largely also because the glass of which a refractor must be made needs to be a very great deal more perfect and is correspondingly more expensive. The success of the one maker, the Rev. Joel H. Metcalf, of Taunton, Mass., shows that there is nothing impossible about the matter ; but an amateur telescope maker will certainly be well advised to begin with a reflector and to make a good reflector before he tries his hand on the refractor. The difficulty in making a reflecting telescope is certainly the mounting. The days have gone by when a man is satisfied with a telescope which can be roughly set to an object and moved on jerkily from time to time as the rotation of the earth carries the object out of the field. He ought certainly now to demand that his telescope shall be mounted equatorially, and driven by clockwork so that he may take photographs with it. But this demands a considerable degree of constructive skill.

The three essentials are : first, that the telescope shall be capable of motion about an axis which can be set rigorously parallel to the axis of the earth ; second, that it can be driven about that axis by clockwork which works so smoothly and unfailingly, that a star falling on the cross-wires of the eye-piece can be kept on those wires without a sudden jump ; and thirdly, that the support of the mirror shall be so made that the mirror is not constrained in any position which the telescope may assume and yet is held rigidly in its proper place. These three conditions, and especially the last, are by no means easy to carry out.

A. R. H.

ANTHROPOLOGY.—I

If we try to take an impartial survey of human research and of the topics of education which have occupied men's minds during the last three or four hundred years (since the human intellect once again began its march of improvement by leaps and bounds) we shall be astonished that so little attention was bestowed and is bestowed on the science of Man himself—the science of Anthropology.

This has been partly due to Man's own vanity, to his assumption that he was so remarkable an item in Creation that he stood apart from the rest of the animal world . . . was of divine origin, in a sense different from other vertebrates and animals. Yet such was a comparatively modern trend of belief in Man's history.

In the times when the foundations of the Hebrew Bible were laid down in men's thoughts and writings somewhere in South-west Asia, there was no such hard and fast distinction ; and the actual text of the First Chapter of Genesis as it is presented to us in the modern versions of the Hebrew Scriptures (still more so, in its more ancient, Babylonian form) is an apt and truthful parable of the emergence of all living forms from unconscious matter, and indeed of the evolution of the planet on which we dwell.

But with the extraordinary distortion and incrustation of beliefs which grew up after the first century A.D., ideas arose as to the origin and status of Man which have no warrant at all in the conclusions of modern science. It is only quite recently that we have been able to treat the human species without prejudice, just as we should discuss any other animal or any other problem of creation.

A Neglected Science

And this victory of reason has been achieved with no loss of wonder, rather an increased reverence and admiration for the processes of creation, even though we may now believe that such processes are usually matters of slow and gradual development, and not a succession of miracles or sudden events, caused by the arbitrary intervention of a *deus ex machina*.

The science of Man is now properly dealt with under two different headings: *Anthropology*, or the description of Man as an animal, as a mammalian vertebrate, a member of the great order which includes Apes, Monkeys and Lemurs ; and *Ethnology*, which, though the word means " a discourse on the nations " is used to describe the science of Man's mind.

Of these two branches the first, Anthropology proper, has been so far the most neglected.

Exact science knows a very great deal about the body of that variety or sub-species of *Homo sapiens* which is represented by the European races. We know not so much, but still a great deal, about the body of the Negro ; less as to the physical characteristics and peculiarities of the Chinese and other Mongols, the Eskimo, the Amerindian,* the Australoid and Melanesian of the Pacific Islands and Australia. And where the science of Anthropology is most lacking at the present time in material for discussion is in regard to Comparative Anatomy.

Comparative Anatomy

First, the comparison of the bones (as to length, breadth, size, shape, excrescences and perforations) ; of teeth (size, depth, cusps, prominence, roots, and angle of setting) ; muscles, brain, nerves, glands, tendons, arteries, entrails, hair and skin ; of the shape of the hand and the foot, of the body odour, the body attitudes, the senses of sight, hearing, smell, taste and touch between one human race, variety and sub-species and another.

Secondly, the comparison of all this physical endowment of *Homo sapiens*—the sole existing species of mankind—and the other human types and species of past ages, represented as they are for the most part only by bones, by the conformation of their vanished brains (as indicated by the impressed surface of the inner side of the skull-case), or by the earliest drawings executed on the walls of caverns, scratched on smooth rock surfaces, or engraved on bone.

And again, the comparison of human anatomy in general with that of the Anthropoid Apes, the Monkeys, the Lemurs and the rest of the Mammalia.

In all these directions we are only at the beginning of Anthropology. It is in that sense one of the youngest of the sciences. We have become so used to the artificial clothing of mankind that it is vaguely thought to be improper, especially for young people, to study Man as an animal with his clothes off.

Yet we find that the more this study is pursued, the more there arise reverence, pity, and purity of thought ; comprehension

* Amerindian is a convenient term for what has hitherto been called the American Indian, the aboriginal peoples of North and South America.

of the marvels of adaptation achieved already by the human frame, together with an understanding of what is lacking, what is wrong, and what may be amended.

The study of Comparative Ethnology, of the wellnigh incredible developments of Man's mind from the mind of the Ape or the mere beast, is an older science than Comparative Anthropology. We may see so far back as the beginning of the seventeenth century that writers in England, France, Germany and Italy were beginning to deal in a scientific manner with human languages, customs, beliefs, legends, arts and crafts; at the present day it is this side of the study of mankind which occupies by far the larger share of our education in Anthropology.

Hands of a Man.

The Primate Man

People who still think that there is something wrong about studying the human body and comparing it with the bodies of other animals, put no restraint on investigations into the human mind and its ancient or its amazing and most modern achievements.

Now, if it may be assumed that my readers, old and young, have not gone as far into Anthropology as I have (though I occupy but a very humble rank amongst the students of humanity), I would set forth the outlines of this study, the main paths of research which they—perhaps with youth and opportunity on their side—might follow a great deal farther than I have done, partly by individual research and observation and partly by studying the already published works on the subject, of which a list will presently be given.

Man—*Homo sapiens*—is a member of the order of Primates, of those creatures—Apes, Monkeys, and Lemurs—which, when they diverged from their common origin with the marsupials, insectivores, and ancestors of the carnivores and hoofed beasts, applied themselves more especially to the development of the hand or fore paw into what might be called an intelligent and many-sided organ, an implement for carrying out the chief orders of the brain.

Hand Habits

Importance was attached to the hand, to the extremity of the fore limb by ancient as well as modern amphibians—frogs and salamanders. It was shared by reptiles, by marsupials, and by the remote mammalian ancestors of the Primates; who may be supposed to have developed out of creatures like insect-eating tree-shrews and the ancestors of the bat, three or four or more million years ago, at the commencement of the great Tertiary Epoch. This sensitiveness about the hand led very early to a bi-pedal progression, that is to say, to walking about, climbing, and jumping on the feet or hinder paws. Yet, ever and again, the lemur-like ancestors of Man and Monkey resumed an attitude on all four legs.

In some of the modern monkeys there is little difference in length between arm

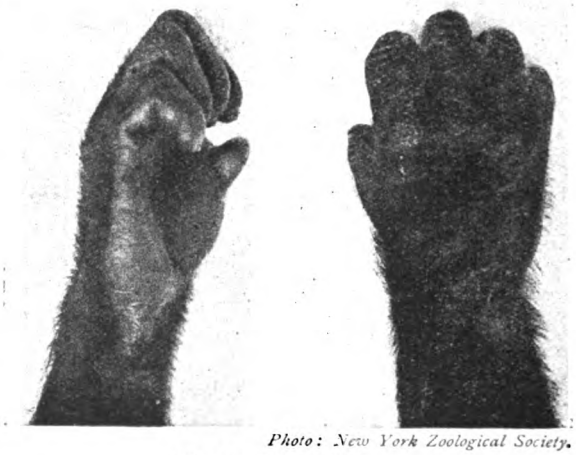


Photo: New York Zoological Society.

Hands of a Gorilla.

and leg, and both alike are equally used in walking or running. Still, the tendency —breaking out ever and again in specialised forms—has always been there, to use the hind limbs for getting about from place to place, and the fore limbs for scratching, picking, catching, investigating, tearing, holding, poking and fighting — the Galago Lemur boxes like a man with its fists, standing up to do so.

The use of the hand for most of these purposes begins as far back as the Opossum and Phalanger types of marsupial, the existing forms of which were evidently very similar in aspect and habit to those generalised insectivores which first began to diverge from the primitive mammals at the close of the Secondary Epoch. Such were already commencing to feel their way towards ascent into the human form: at a time when the huge dinosaurs, the flying reptiles, and the great sea saurians were dying out, perhaps from having become too complicated in their body-structure to be able to stand changes of climate or changes of food.

Photo: Sir H. H. Johnston.

THE LARGE TAIL-LESS LEMUR

is a native of Madagascar and is akin to the extinct forms of Lemur which grew to the size of a man.

Insectivores with this "hand habit"—with hands something like those of the extraordinary Aye-aye Lemur at the present day, with even longer, more slender and wider-extended fingers—developed into bats and became flying mammals; others into creatures like the modern Lemur. From Lemurs were evolved in Africa during the Eocene and Oligocene periods forms scarcely to be distinguished from the modern American Monkey. Some of these "American Monkeys" (the ancestors of them, that is to say) crossed over from West Africa into Brazil whilst there still existed a land bridge across the Equatorial Atlantic connecting South America with Africa.

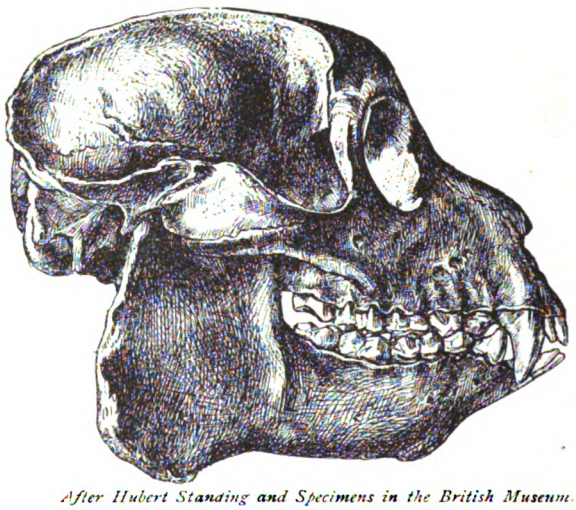
Similar types, together with the earlier Lemurs, had also reached Madagascar, where in course of time they died out. In Africa proper what we now call the American type of monkey developed into the Old World or narrow-nosed type, which in course of time spread over the Mediterranean basin, Asia and the Malay Archipelago, and developed in one direction into Baboons and Macaques, with short tails or no tail at all, and in another into the Anthropoid Apes, with no visible tail outside the skin, with

very long arms, long fingers and weak thumbs, naked cheeks and noses, and a renewed tendency to run and jump on their hind legs only and to use their hands for a variety of intelligent purposes.

Some of these primitive anthropoid apes (not larger than a middle-sized dog, perhaps), about two million years ago, adapted themselves to an exclusively forest life in the dense forests which then covered so much of the tropical and even temperate regions of the Old World. But other genera, on the contrary, preferred — like the baboons — an existence more out in the open; until at last they became indigenous rather to the grassy plains and the rocky country than to the woods.

Their hind limbs grew longer and stronger, so that although their gait was shambling and bowed at the knee, they were active on their feet, and assumed, more and more, an upright position when they moved about. Their long arms and long fingers grew gradually shorter and more muscular. The thumb, moreover, which at one stage in his career the human ancestor had greatly neglected, had a revived importance, so that although it still bears evidence of its one-time neglect in being one joint shorter than the other fingers, the most was made of it. Its segments of bone grew longer, its muscles and tendons stronger. For three or four million years it had been placed like the big toe in opposition to the other digits, so that objects could be more readily and sensitively grasped and picked up.

This type of anthropoid with serviceable hands, with shortened feet, in which—unlike the case of the hand development—the big toe was growing more towards the other toes and becoming less and less prehensile, was probably characteristic of much of the open country of Northern Africa, Western Asia, and Southern Europe in the latter part of the Miocene period.



After Hubert Standing and Specimens in the British Museum.

MESOPROPITHECUS PITHECOIDES.

Fossilised skull of a missing link between the lemur and the monkey, found in Madagascar.

This was the period in which the Elephant order was developing some of its strangest and most monstrous types; in which there were extraordinary forms of Giraffe: and the Rhinoceroses were specialising, the Deer, Cattle and Antelopes evolving. In this middle age of the vastly long Tertiary Epoch, there were already large primitive Cats with huge canine teeth (the Sabre-toothed "Tigers"); and—could we transport ourselves back in imagination—we should have seen the leopard-like ancestor of the Jaguar, Tiger, and Lion abundant all over the Old World and just beginning to penetrate from Asia into North America.

At the close of the Miocene, or more likely at the beginning of the Pliocene period, we should probably have noticed that these biggish anthropoid apes, running and jumping on their hind legs, were beginning to specialise in two directions. Some of them found it easier in the struggle for existence to revert once more to a forest life in the warmer regions of Asia and Africa. Once again, from living so much in the trees, their arms grew longer and their legs shorter, and when they were on the ground they found it necessary to aid their progress by dropping on all fours, with the knuckles of their fingers just touching the ground: in short, they became in course of time Orangs, Chimpanzees and Gorillas.

The Gorilla, though in some respects the nearest allied of all living beings to *Homo sapiens*, might nevertheless be what is called a "convergent" type — that is to say, some form of chimpanzee-like ape that, owing to great increase in bulk and change of habits, found itself obliged to live more and more on the ground. Consequently the extremity of the limb in the gorilla is more like a human foot and less like the "hinder hand" of the chimpanzee.

The anthropoids, it might be mentioned, differ chiefly from the baboons and monkeys in being no longer fully adapted for quad-

rupedal progression. The Gibbons cannot run on all fours. When in the trees they move about by jumping on their hind limbs and catching the branches with their long arms and long fingers. When they are on the ground they walk or run upright like a man, holding their long arms upwards to balance themselves. The Orang, and still more, the Chimpanzee and Gorilla, progress in the trees on the plan of the Gibbon, but when on the ground help themselves along by leaning on the knuckles of their fingers; in fact, they have reverted to the old four-footed method.

COMPARATIVE STUDIES IN—

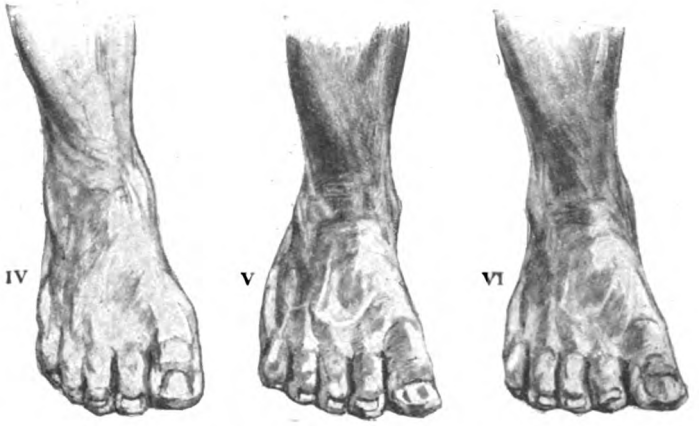
The Gorilla can easily stand upright, as can the Chimpanzee, and may even make some staggering steps forwards on his hind limbs without dropping to use his hands; but he cannot run about on his legs like a man or a gibbon.

The Anthropoids differ also from the Monkeys in being without a visible tail, in several of their muscles, in the serum of their blood, and in the conformation of their viscera; in all of which directions they approach nearer to the human family.

As contrasted with our forest cousins, however, those anthropoids that resolved to "stick it"—if I may use a slang phrase; to go on contending with the rivalry of the other improved beasts in the open country of plains, river valleys and bare hills, were becoming more and more carnivorous in diet, more and more "hunting" animals in their habits. They grew at the same time more and more intelligent in the struggle for existence.

The anthropoid apes of the present day have a distinct liking for flesh. They catch and eat birds, lizards and very small beasts—chiefly birds. They like shell fish, and eat many kinds of insects. It is even said of the Gorilla that he will bury the dead body of a leopard killed in self-defence by three Gorillas banded together, and after the flesh has softened will dig it up and devour it.

Nevertheless in the main the anthropoids are vegetarians; and it was almost a revolution in their habits which transformed a section of them—the ancestors of man—into a carnivorous and blood-thirsty beast, cruel and ever ready to kill and devour, if need be, Man himself.



—THE FOOT OF MAN.

I., IV. European foot; II., V. Foot of Negro (Congo Pygmy); III., VI. Foot of Oceanic Negro (Solomon Islands).

The change has been analogous to that in the Brown Rat, whose ancestors for millions of years had developed teeth, structure, habits for gnawing roots, bark, nuts, grain, but which during two hundred years of world wandering is becoming more and more a flesh-eater. H. H. J.

Continued from page 423.

LANGUAGES:

Contributors:—LATIN, GREEK and FRENCH (E. A. Baker, M.A, D.Lit.). GERMAN (M. A. Lewenz, M.A. [Lond.]). SPANISH, RUSSIAN and ITALIAN (Alfred Calvert, First Prizeman in Modern Languages, R.S.A., London).

LATIN.—VIII

THE Latin verb has also certain verbal substantives and adjectives, which will be duly set out in the conjugations.

As a preliminary to the regular conjugations, the conjugation of the irregular verb **sum** will be given, since it is a most important word, especially as it is used in the function of an auxiliary.

The Verb **sum**, *I am.*
Chief Parts: **sum**, **fŭī**, **fŭtūrŭs**, **essĕ**, *to be.*

Indicative Mood

1. PRESENT	2. IMPERFECT
Sing.	*Sing.*
sum, *I am.*	ĕram, *I was.*
ĕs, *thou art.*	ĕrās, *thou wast.*
est, *he is.*	ĕrăt, *he was.*
Plur.	*Plur.*
sŭmŭs, *we are.*	ĕrāmŭs, *we were.*
estĭs, *you are.*	ĕrātĭs, *ye were.*
sunt, *they* are.	ĕrant, *they were.*

3. FUTURE	4. PERFECT
Sing.	*Sing.*
ĕrō, *I shall be.*	fŭ-**ī**, *I have been.*
ĕrĭs, *thou wilt be.*	fŭ-**istī**, *thou hast been.*
ĕrĭt, *he will be.*	fŭ-**ĭt**, *he has been.*
Plur.	*Plur.*
ĕrĭmŭs, *we shall be.*	fŭ-**ĭmŭs**, *we have been.*
ĕrĭtĭs, *ye will be.*	fŭ-**istĭs**, *ye have been.*
ĕrunt, *they will be.*	fŭ-**ērunt** or fŭ-**ērĕ**, *they have been.*

5. PLUPERFECT	6. FUTURE PERFECT
Sing.	*Sing.*
fŭ-**ĕram**, *I had been.*	fŭ-**ĕrō**, *I shall have been.*
fŭ-**ĕras**, *thou hadst been.*	fŭ-**ĕrĭs**, *thou wilt have been.*
fŭ-**ĕrăt**, *he had been.*	fŭ-**ĕrĭt**, *he will have been.*
Plur.	*Plur.*
fŭ-**ĕrāmŭs**, *we had been.*	fŭ-**ĕrĭmŭs**, *we shall have been.*
fŭ-**ĕrātis**, *ye had been.*	fŭ-**ĕrĭtĭs**, *ye will have been.*
fŭ-**ĕrant**, *they had been.*	fŭ-**ĕrint**, *they will have been.*

Subjunctive Mood

1. PRESENT	2. IMPERFECT
Sing.	*Sing.*
sim, *I may be.*	essem, or fŏrem, *I might be.*
sīs, *thou mayst be.*	essēs, or fŏrēs, *thou mightst be.*
sīt, *he may be.*	essĕt, or fŏrĕt, *he might be.*
Plur.	*Plur.*
sīmŭs, *we may be.*	essēmŭs, or fŏrēmŭs, *we might be.*
sītĭs, *ye may be.*	essētĭs, or fŏrētĭs, *ye might be.*
sint, *they may be.*	essent, or fŏrent, *they might be.*

3. PERFECT	4. PLUPERFECT
Sing.	*Sing.*
fŭ-**ĕrim**, *I may have been.*	fŭ-**issem**, *I might have been.*
fŭ-**ĕrĭs**, *thou mayst have been.*	fŭ-**issēs**, *thou mightst have been.*
fŭ-**ĕrĭt**, *he may have been.*	fu-**issĕt**, *he might have been.*
Plur.	*Plur.*
fŭ-**ĕrĭmŭs**, *we may have been.*	fŭ-**issēmŭs**, *we might have been.*
fŭ-**ĕritis**, *ye may have been.*	fŭ-**issētĭs**, *ye might have been.*
fŭ-**ĕrint**, *they may have been.*	fŭ-**issent**, *they might have been.*

Imperative Mood

1. PRESENT	2. FUTURE
Sing.	*Sing.*
ĕs, *be thou.*	**esto**, *thou shalt be.*
	est-**o**, *he shall be.*
Plur.	*Plur.*
estĕ, *be ye.*	es-**tōtĕ**, *ye shall be.*
	suntō, *they shall be.*

Infinitive

PRESENT	FUTURE
essĕ, *to be.*	fŏrĕ, or fŭtūrŭs esse, or fŏrĕ, *to be about to be.*
PERFECT	
fŭ-**issĕ**, *to have been.*	

GERUND	SUPINE
None.	None.

Participles

PRESENT	FUTURE
None.	fŭturŭs, fŭturĕ, fŭturum.

The Four Regular Conjugations

Latin regular verbs fall into four conjugations distinguished from each other by the characteristic letter of the present imperative or infinitive active, thus :—

	Ind. Pres.	*Imper.*	*Infin.*
1st or **A**-conjugation :—			
-ārĕ	**ămō** *I love,*	**ămā**	**ămārĕ**
2nd or **E**-conjugation :—			
-ērĕ	**mŏnĕō** *I advise,*	**mŏnē**	**mŏnērĕ**
3rd or Consonant or **U**-conjugation :—			
-ĕrĕ	**lĕgō** *I read,*	**lĕgĕ**	**lĕgĕrĕ**
4th or **I**-conjugation :—			
-īrĕ	**audīō** *I hear,*	**audī**	**audīrĕ**

First or A-Conjugation—Active Voice

Example—ămō, *I love,* bases **ăm-**, **ămāv-**, **ămāt-**.

Chief Parts : ăm-**ō**, ămāv-**ī**, ămāt-**um**, ăm-**ārĕ**.

Indicative Mood

PRESENT	IMPERFECT
Sing.	*Sing.*
ăm-**ō**, *I love.*	ăm-**ābam**, *I was loving.*
ăm-**ās**, *thou lovest.*	ăm-**ābās**, *thou wast loving.*
ăm-**ăt**, *he loves.*	ăm-**ābăt**, *he was loving.*
Plur.	*Plur.*
ăm-**āmus**, *we love.*	ăm **ābāmŭs**, *we were loving.*
ăm-**ātis**, *ye love.*	ăm **ābātis**, *ye were loving.*
ăm-**ant**, *they love.*	ăm **ābant**, *they were loving.*

FUTURE	PERFECT
Sing.	*Sing.*
ăm-**ābō**, *I shall love.*	ămāv-**ī**, *I loved* or *have loved.*
ăm-**ābĭs**, *thou shalt love.*	ămāv-**istī**, *thou lovedst* or *hast loved.*
ăm-**ābĭt**, *he will love.*	ămāv-**ĭt**, *he loved* or *has loved.*
Plur.	*Plur.*
ăm-**ābĭmŭs**, *we shall love.*	ămāv-**ĭmŭs**, *we loved* or *have loved.*
ăm-**ābĭtis**, *ye will love.*	ămāv **istis**, *ye loved* or *have loved.*
ăm-**ābunt**, *they will love.*	ămāv-**ērunt**,or ămāv-**ērĕ** *they loved* or *have loved.*

PLUPERFECT	FUTURE PERFECT
Sing.	*Sing.*
ămāv-**ĕram**, *I had loved.*	ămāv-**ĕrō**, *I shall have loved.*
ămāv-**ĕrās**, *thou hadst loved.*	ămāv-**ĕris**, *thou wilt have loved.*
ămāv-**ĕrăt**, *he had loved.*	ămāv-**ĕrit**, *he will have loved.*
Plur.	*Plur.*
ămāv-**ĕrāmŭs**, *we had loved.*	ămāv-**ĕrĭmŭs**, *we shall have loved.*
ămāv-**ĕrātis**, *ye had loved.*	ămāv-**ĕrĭtis**, *ye will have loved.*
ămāv-**ĕrant**, *they had loved.*	ămāv-**ĕrint**, *they will have loved.*

Subjunctive Mood

PRESENT	IMPERFECT
Sing.	*Sing.*
ăm **em**, *I may love.*	ăm **ārem**, *I might love.*
ăm **ēs**, *thou mayst love.*	ăm-**ārēs**, *thou mightst love.*
ăm-**ĕt**, *he may love.*	ăm-**ārĕt**, *he might love.*
Plur.	*Plur.*
ăm-**ēmŭs**, *we may love.*	ăm **ārēmŭs**, *we might love.*
ăm-**ētis**, *ye may love.*	ăm-**ārētis**, *ye might love.*
ăm-**ent**, *they may love.*	ăm-**ārent**, *they might love.*

PERFECT	PLUPERFECT
Sing.	*Sing.*
ămāv-**ĕrim**, *I may have loved.*	ămāv-**issem**, *I might have loved.*
ămāv-**ĕris**, *thou mayst have loved.*	ămāv-**issēs**, *thou mightst have loved.*
ămāv-**ĕrit**, *he may have loved.*	ămāv-**issĕt**, *he might have loved.*
Plur.	*Plur.*
ămāv-**ĕrimŭs**, *we may have loved.*	ămāv-**issēmŭs**, *we might have loved.*
ămāv-**ĕritis**, *ye may have loved.*	ămāv-**issētis**, *ye might have loved.*
ămāv-**ĕrint**, *they may have loved.*	ămāv-**issent**, *they might have loved.*

Imperative Mood

PRESENT

Sing.	*Plur.*
ăm-**ā**, *love thou.*	ăm-**ātĕ**, *love ye.*

FUTURE

ăm-**ātō**, *thou shalt love.*	ăm **ātōtĕ**, *ye shall love.*
ăm-**ātō**, *he shall love.*	ăm-**antō**, *they shall love.*

Infinitive Mood

PRESENT	PERFECT
ăm-**ārĕ**, *to love.*	ămāv-**issĕ**, *to have loved.*

FUTURE

ămātūr-**ŭs** essĕ, *to be about to love.*

GERUND		SUPINE	
N. Acc.	ăm-**andum**, *loving.*	*Acc.*	ămāt-**um**, *to love.*
Gen.	ăm-**andī**	*Abl.*	ămāt-**ū**, *in loving* or *to be loved.*
Dat.	ăm-**andō**		
Abl.	ăm-**andō**		

Participles

PRESENT	FUTURE
ăm-**ans**, **-antis**, *loving.*	ămāt-**ūrŭs**, **-ūră**, **-ūrum**, *about to love.*

SECOND OR E-CONJUGATION—ACTIVE VOICE

EXAMPLE—mŏnĕō, *I remind.* base, **mon-**.

Chief Parts: mŏn-**ĕō**, mŏnŭ-**ī**, mŏnĭt-**um**, mŏn-**ērĕ**.

Indicative Mood

PRESENT	IMPERFECT
Sing.	*Sing.*
mŏn-**ĕō**, *I advise.*	mŏn-**ēbam**, *I was advising.*
mŏn-**ēs**, *thou advisest.*	mŏn-**ēbas**, *thou wast advising.*
mŏn-**ĕt**, *he advises.*	mŏn-**ēbăt**, *he was advising.*
Plur.	*Plur.*
mŏn-**ēmŭs**, *we advise.*	mŏn-**ēbāmŭs**, *we were advising.*
mŏn-**ētis**, *ye advise.*	mŏn-**ēbātis**, *ye were advising.*
mŏn-**ent**, *they advise.*	mŏn-**ēbant**, *they were advising.*

FUTURE	PERFECT
Sing.	*Sing.*
mŏn-**ēbō**, *I shall advise.*	mŏnŭ-**i**, *I advised* or *have advised.*
mŏn-**ēbis**, *thou will advise.*	mŏnŭ-**istī**, *thou advisedst* or *hast advised.*
mŏn-**ēbit**, *he will advise.*	mŏnŭ-**it**, *he advised* or *has advised.*
Plur.	*Plur.*
mŏn-**ēbĭmŭs**, *we shall advise.*	mŏnŭ-**ĭmŭs**, *we advised* or *have advised.*
mŏn-**ēbĭtis**, *ye will advise.*	mŏnŭ-**istis**, *ye advised* or *have advised.*
mŏn-**ēbunt**, *they will advise.*	mŏnŭ-**ērunt** or monŭ-**ērĕ**, *they advised* or *have advised.*

PLUPERFECT	FUTURE PERFECT
Sing.	*Sing.*
mŏnŭ-**ĕram**, *I had advised.*	mŏnŭ-**ĕrō**, *I shall have advised.*
mŏnŭ-**ĕrās**, *thou hadst advised.*	mŏnŭ-**ĕrīs**, *you will have advised.*
mŏnŭ-**ĕrăt**, *he had advised.*	mŏnŭ-**ĕrĭt**, *he will have advised.*
Plur.	*Plur.*
mŏnŭ-**ĕrāmŭs**, *we had advised.*	mŏnŭ-**ĕrĭmŭs**, *we shall have advised.*
mŏnŭ-**ĕrātis**, *ye had advised.*	mŏnŭ-**ĕrĭtis**, *ye will have advised.*
mŏnŭ-**ĕrant**, *they had advised.*	mŏnŭ-**ĕrint**, *they will have advised.*

Subjunctive Mood

PRESENT	IMPERFECT
Sing.	*Sing.*
mŏn-**ĕam**, *I may advise.*	mŏn-**ērem**, *I might advise.*
mŏn-**ĕās**, *thou mayst advise.*	mŏn-**ērēs**, *thou mightst advise.*
mŏn-**ĕăt**, *he may advise.*	mŏn-**ērĕt**, *he might advise.*
Plur.	*Plur.*
mŏn-**ĕāmŭs**, *we may advise.*	mŏn-**ērēmŭs**, *we might advise.*
mŏn-**ĕătis**, *ye may advise.*	mŏn-**ērētis**, *ye might advise.*
mŏn-**ĕant**, *they may advise.*	mŏn-**ērent**, *they might advise.*

PERFECT	PLUPERFECT
Sing.	*Sing.*
mŏnŭ-**ĕrim**, *I may have advised.*	mŏnŭ-**issem**, *I might have advised.*
mŏnŭ-**ĕrīs**, *thou mayst have advised.*	mŏnŭ-**issēs**, *thou mightst have advised.*
mŏnŭ-**ĕrĭt**, *he may have advised.*	mŏnŭ-**issĕt**, *he might have advised.*
Plur.	*Plur.*
mŏnŭ-**ĕrĭmŭs**, *we may have advised.*	mŏnŭ-**issēmŭs**, *we might have advised.*
mŏnŭ-**ĕrĭtis**, *ye may have advised.*	mŏnŭ-**issētis**, *you might have advised.*
mŏnŭ-**ĕrint**, *they may have advised.*	mŏnŭ-**issent**, *they might have advised.*

Imperative Mood

PRESENT	
Sing.	*Plur.*
mŏn-**ē**, *advise thou.*	mŏn-**ētĕ**, *advise ye.*

FUTURE	
mŏn-**ētō**, *thou shalt advise.*	mŏn-**ētōtĕ**, *ye shall advise.*
mŏn **ētō**, *he shall advise.*	mŏn-**entō**, *they shall advise.*

Infinitive Mood

PRESENT	PERFECT
mŏn-**ērĕ**, *to advise.*	mŏnŭ **issĕ**, *to have advised.*

FUTURE

mŏnĭtūr-**ŭs** essĕ, *to be about to advise.*

GERUND	SUPINE
N. Acc. mŏn-**endum**, *advising.*	*Acc.* mŏnĭt-**um**, *to advise.*
Gen. mŏn-**endī**.	*Abl.* mŏnĭt-**ū**, in *advising* or *to be advised.*
Dat. mŏn-**endō**.	
Abl. mŏn-**endō**.	

Participles

PRESENT	FUTURE
mŏn-**ens**, **-entis**, *advising.*	mŏnĭt-**ūrŭs**, **-ūrā**, **-ūrum** *about to advise.*

For practice the following may be conjugated, like **ămō**, **hŏnōrō**, **-āvī**, **-ātum**, *to honour;* **cŏrōnō**, **-āvī**, **-ātum**, *to crown;* **iūdĭcō**, **-āvī**, **-ātum**, *to judge;* and like **mŏnĕō**, **-hăbĕō**, **-ŭī**, **-ĭtum**, *to have* or *possess;* **terrĕō**, **-ŭī**, **-ĭtum**, *to frighten;* and **exercĕō**, **-ŭī**, **-ĭtum**, *to exercise.*

The student should note that the renderings given of the Latin do not cover all the meanings that may be implied. Thus **ămō** may mean *I love* or *I am loving*; **ămābam,** *I loved, was loving,* or *used to love*; **ămem,** *I can* or *may love*; **ămāvissem,** *I might, would,* or *should have loved,* or it may simply be translated *I had lov d.*

The characteristic vowel (**a** in the first and **e** in the second conjugation) is seen in all forms of the present indicative and imperative. In the fourth conjugation the same will be noticed of the characteristic vowel **i**; but in the third or consonant conjugation the place is taken by **ĕ, ĭ,** or **u.**

VOCABULARY

ambŭlō, -āvī, -ātum, 1, *to walk.*
cantō, -āvī, -ātum, 1, *to sing.*
certō, -āvī, -ātum, 1, *to contend.*
cītō, *quickly.*
cīvīs, -īs, c., *citizen.*
clāmor, -ōris, m., *shout, noise.*
consŭl, -ŭlĭs, m., *consul.*
cūrō, -āvī, -ātum, 1, *to care for, to look after.*
exemplum, -ī, n., *example, pattern.*
expugnō, -āvī, -ātum, 1, *to storm, to capture.*
fortĕ, *by chance.*
gŭbernō, -āvī, -ātum, 1, *to govern.*
impendĕō, -ŭī, -ĭtum, 2, *to hang over.*
infāmĭă, -ae, f., *dishonour.*
iūdĭcĭum, -ī, n., *trial, judgment.*
mŏvĕō, mōvī, mōtum, 2, *to move.*
nīvālis, -e, *snowy.*
nunquam, *never.*
obsĭdĕō, -sēdī, -sessum, 2, *to besiege.*
postĕā, *after that.*
postĕăquam, *after* (conj.).
quum (cum), *when.*
sălŭs, -ūtĭs, f., *safety.*
sempĕr, *always.*
sōlum, *alone, only.*
tĕnĕō, -ŭī, tentum, 2, *to hold, to retain.*
terrŏr, -ōris, m., *great fear.*
tĭmĕō, -ŭī, 2, *to be afraid of.*
tĭmŏr, -ōrĭs, m., *fear.*
unquam, *at any time, ever.*
vălĕō, -ŭī, -ĭtum, 2, *to be strong, to avail.*
vŏcō, -āvī, -ātum, 1, *to call.*

Exercise 7

Translate into English:—

1. Nos Britanniae regis milites sumus. 2. Insulae fecundissimae agricolae estis. 3. Saepe pauperes benevolentiores quam divites sunt. 4. Fortes este, et feliciores aliis hominibus eritis. 5. Sua sponte multi in urbe cum regina manent. 6. Quod praemium iis gratissimum videtur? 7. Aliqui peregrini in oppido nostro manent. 8. Equis hic est? Hic est meus amicus. 9. Quidam bonorum pauperes sunt. 10. Quot homines tot sententiae.

Translate into Latin:—

1. The most benevolent people are not always the richest. 2. Nothing is rarer than prudence. 3. The brave yield to death rather than to dishonour. 4. The queen remains on her knees, a suppliant. 5. The edge of the axe is not sharp. 6. The boy's hands tremble with fear. 7. As the leaders are such will the people be. 8. All men are kind judges of their own. 9. Who has a sweeter voice than your sister?

Exercise 8

Translate into English:—

1. Regina cum liberis suis in horto ambulat. 2. Cives cum civibus de virtute certabant. 3. Providi consulis est in secundis et adversis rebus rempublicam curare. 4. Multos amicos habeo qui memoriam meam tenebunt. 5. Milites templum multis floribus coronant. 6. Iudico eum hostem fuisse. 7. Crassus habebat plus quam ducentos servos. 8. Multum ad terrendos nostros valuit clamor. 9. Erat forte nivale tempus quum hostes castra obsidebant. 10. Nautae certabant quis eorum gubernaret.

Translate into Latin:—

1. We shall always love our father and mother. 2. I happened to be walking with your friend. 3. The king who governs the state ought to look after the safety of the citizens. 4. If we are afraid of death, fear will always be hanging over us. 5. The Romans besiege the city and take it. 6. I have never feared death, but only dishonour. 7. What were you singing, my friend? 8. If so many examples of virtue do not move you, nothing will ever move you. 9. P. Africanus, after he had been consul twice, summoned L. Cotta to trial. 10. The dread of death terrifies many people.

Key to Exercise 6

1. At the same time enemies come into Italy. 2. All our strength is situated in the mind and the body. 3. I myself saw this thing. 4. That man gives me many rewards. 5. This is the man who remains at home. 6. This is the very cause of the war. 7. Men furnished with such authority as you hold. 8. The glory of wealth and beauty is fleeting and fragile. 9. He appeared to himself a wonderful and extremely wise man. 10. The whole power over this matter resides in you, O judges.

1. Is est idem rex qui in Italiam venit. 2. Stultus impotens sui est. 3. Cui est ille hortus? Omnis mihi est. 4. Huic duci fortissimi milites sunt. 5. Mirum desiderium urbis, meorum, et tui mihi est. 6. Amici non immemores nostri sunt. 7. Mors est communis sors omnium hominum. 8. Qui poeta laudes Italiae cantat? 9. Haec dona mihi gratissima sunt. 10. Iste oppidum in manibus hostium est.

E. A. B.

FRENCH.—VIII

Disjunctives.—THE disjunctive pronouns are not inflected, but form their genitive and dative by means of the prepositions **de** and **à.** They may be tabulated thus—

	Sing.	
Nom. and Obj.	moi, *I, me.*	toi, *thou, thee.*
	lui, *he, him.*	elle, *she, her.*
Gen.	de moi, *of me.*	de toi, *of thee.*
	de lui, *of him.*	d'elle, *of her.*
Dat.	à moi, *to me.*	à toi, *to thee.*
	à lui, *to him.*	à elle, *to her.*
	Plur.	
Nom. and Obj.	nous, *we, us.*	vous, *you.*
	eux (m.), *they.*	elles (f.), *they.*
Gen.	de nous, *of us.*	de vous, *of you.*
	d'eux, *of them.*	d'elles, *of them.*
Dat.	à nous, *to us.*	à vous, *to you.*
	à eux, *to them.*	à elles, *to them.*

The disjunctive pronouns appear as the subject of sentences in the following cases:

(1) When the distinction between two persons or things is being emphasised, as in—

Lui n'a dit cela, mais **eux** ont parlé tout à fait autrement.	*He said this, but they spoke quite otherwise.*

(2) When they are in apposition with a pronoun for the sake of emphasising the person, as in—

Moi, je le crois.	*I believe it myself.*

(3) When they are joined with another word by a simple conjunction, as in—

Mon père et moi nous sommes venus.	*My father and I have come.*

The disjunctive pronouns are used as complement to the verb—

(1) After the verb **être**, *to be*, as in—

L'**état**, c'est moi.	*The State, I am the State.*

(2) After prepositions, as in—

Ce jardin est-il à toi ?	*Is this garden yours ?*
Il viendra après moi.	*He will come after me.*
C'est la poétique à lui.	*It is his poetic* (*creed for him*).

(3) After conjunctions, as in—

Vous êtes beaucoup plus riche que moi.	*You are a great deal richer than I.*
Vous avez plus de mérite que lui.	*You have more merit than he.*

(4) In answer to questions, as in—

Qui va là ? *Who goes there ?* Moi. *I.*

Reflexive Pronouns. — The objective and dative of the first and second personal pronouns, viz. **me**, *myself*, *to myself*, **te**, *thyself*, *to thyself*, **nous**, *ourselves*, *to ourselves*, **vous**, *yourselves*, *to yourselves*, are used after reflexive verbs, i.e. those expressing action reflected back upon the subject. In the third person the reflexive pronoun is **se** (unchanged in the plural), *himself*, *herself*, *itself*, *themselves*, *to himself*, *to herself*, *to itself*, *to themselves*.

Examples:—

Je m'assieds.	*I sit down* [lit. *I sit* (*myself*) *down*].
Nous nous asseyons.	*We sit down.*
Voulez-vous vous asseoir ?	*Will you sit down ?*

Disjunctive Reflexives. — The disjunctives are given a reflexive sense or made more emphatic by the addition of même, thus—

moi-même, *myself*, toi-même, *thyself*, lui-même, *himself*, elle-même, *herself*, soi-même, *oneself*.

nous-mêmes, *ourselves*, vous-mêmes, *yourselves*, eux-mêmes, *themselves*, elles-mêmes, *themselves*.

Demonstrative Pronouns.—The demonstrative pronouns are (1) the indeclinable neuter **ce**, *it*, *he*, *she*, or *they*, with the indeclinable **ceci**, *this one*, and **cela**, *that one*, formed by union with the particles **ci**, *here*, and **là**, *there ;* and (2) the declinable **celui**, *he*, *that*, *that one*, **celle**, *she*, *that*, **ceux**, **celles**, *they*, *those*. **Ci** and **là** are also joined to **celui** with a hyphen, thus—

celui-ci, celle-ci, *this, the latter.*	ceux-ci, celles-ci, *these, the latter.*
celui-là, celle-là, *that, the former.*	ceux-là, celles-là, *those, the former.*

The pronoun **ce** must be carefully distinguished from the demonstrative adjective **ce**, which always stands before a noun. The pronoun **ce** is used principally (1) with the verb **être**, *to be*, like the English anticipative *it*, thus—

C'est lui.	*It is he.*
C'était la vraie beauté.	*It was true beauty.*
Ce sont mes amis qui l'ont dit.	*It is my friends who have said it.*
C'est ainsi qu'il avait pris la tête de ses grenadiers sur la place de la Bastille.	*It was thus that he took his place at the head of his grenadiers in the Place de la Bastille.*

It is also used (2) as antecedent to the relative pronouns **qui** (*who*), **que**, *whom*, **quoi**, *what*, **dont**, *whose*, as in—

Savez-vous ce **qui** est arrivé ?	*Do you know what has happened ?*

Celui, celle, ceux, celles are used only before a relative or the preposition **de**, thus—

Ses moustaches aiguës comme celles d'un chat et qui à la pointe commencaient à blanchir.	*His pointed moustaches like those of a cat and which were beginning to turn white at the ends.*

Celui-ci and **celui-là** are used in distinguishing between two things that have been coupled together, as in—

Vous avez celui-ci, mais vous n'aurez pas celui-là.	*You have this one* (the latter), *but you shall not have that one* (the former).

Ceci refers to the nearer object of two, **cela** to the more distant, as in—

Nous n'avons pas ceci, nous avons cela.	*We have not this, we have that.*

Either pronoun may be used without any expressed opposition, though usually such is implied, **ceci** referring to what follows, **cela** to what has just been said, as in—

Retiens bien ceci : la paresse est la mère de tous les vices.	*Bear this well in mind, idleness is mother of all the vices.*
L'orgueil est un grand défaut ; retenez bien cela.	*Pride is a great fault ; bear that well in mind.*

Possessive Pronouns.—The possessive pronouns corresponding to the possessive adjectives, **mon**, *my*, **ton**, *thy*, **son**, *his* or *her*, **nôtre**, *our*, **vôtre**, *your*, **leur**, *their*, are the following:

le mien, la mienne, les miens, les miennes, *mine.*
le tien, la tienne, les tiens, les tiennes, *thine.*
le sien, la sienne, les siens, les siennes, *his, hers,* or *its.*
le nôtre, la nôtre, les nôtres, *ours.*
le vôtre, la vôtre, les vôtres, *yours.*
le leur, la leur, les leurs, *theirs.*

They agree in gender and number with the noun which they represent and of which they denote possession, as in—

J'ai votre livre et le mien.	*I have your book and mine.*
Vos maisons et les miennes.	*Your houses and mine.*
Vous avez votre plume et la nôtre.	*You have your pen and ours.*
Vos champs et les siens.	*Your fields and his.*

They are used in the plural to denote relatives, friends, etc., thus—

Toi et les tiens, vous et les vôtres.	*Thou and thine, you and yours.*

Note that **le nôtre** and **le vôtre** take the circumflex accent as pronouns.

VOCABULARY

anglais, *English.*
apprenez, *learn* (you).
le besoin, *want, need.*
la chandelle, *the candle.*
le chandelier, *the candlestick.*
cherchez, *search* (you).
le commencement, *the beginning.*
comprenez-vous? *do you understand?*
donnez-moi, *give me.*
égal, *equal.*
l'épouse, f., *the wife.*
le fer, *iron.*
la fleur, *the flower.*
italien, *Italian.*
parler, *to speak.*
le prêtre, *the priest.*
pris, *taken.*
revenir, *to return.*
je sais, *I know.*
seulement, *only.*
souvenir, *to remember.*
le souvenir, *recollection.*
trouvez, (you) *find.*
utile, *useful.*
le verre, *the glass.*
le voisin, *the neighbour.*
voulu, *wished.*

Exercise 14

1. That which is true is beautiful. 2. My candlesticks and those of your brother. 3. My candles and those of our neighbours. 4. Has my sister your flowers or my cousin's (those of my cousin)? 5. She has neither mine nor my cousin's, she has her own. 6. No, madam, I have not your flowers, I have my own. 7. I have as many of these as of those. 8. Have you not more glasses than plates? 9. I have more of the latter than the former. 10. Has not the merchant more iron than steel? 11. He has not as much of the latter as the former. 12. The gardens of the Italians are more beautiful than those of the English. 13. This is the most beautiful of all the gardens in the city. 14. Has the innkeeper your horses? 15. The innkeeper has neither my horses nor yours. 16. No, sir, I have not your pens, I have my own. 17. I tell you this. 18. It was I. 19. Has his wife her dress or yours?

Exercise 13

1. Cela m'est égal. 2. Je le sais, moi. 3. Ce que vous apprenez est utile. 4. Trouvez-vous ce que vous cherchez? 5. Ce que j'avais pris pour la fin, c'était seulement le commencement. 6. Ce n'est pas le médecin dont nous avons besoin, c'est du prêtre. 7. Ce n'est pas ce que nous avons demandé. 8. Vous et moi nous n'aurions pas le temps. 9. Je vous demande bien pardon de vous parler de moi. 10. C'était le souvenir de cela qui me revenait. 11. Mon jardin et celui de mon frère. 12. Ma plume et celle de ma mère. 13. C'est moi qui l'ai voulu. 14. Cette maison est-elle la vôtre ou la sienne? 15. Voici mes souliers: donnez-moi les vôtres. 16. Comprenez-vous ce que je vous dis? 17. Il n'a ni les vôtres ni les miens. 18. A-t-il ceux de nos voisins? 19. Il ne les a pas. 20. Avez-vous ceux-ci ou ceux-là?

Key to Exercise 10

1. Le domestique a-t-il cette salière? 2. Il n'a pas cette salière-ci, il a celle-là. 3. Le boulanger a-t-il du biscuit? 4. Le boulanger n'a pas de biscuit, il a du pain. 5. Ses chevaux ne sont pas restifs, mais ses mules sont très restives. 6. Avez-vous une paire de bas de laine? 7. J'ai une belle paire de bas de soie. 8. Le médecin a-t-il les bonnes maisons ou les mauvaises? 9. Il n'a ni les bonnes ni les mauvaises. 10. Mes écoliers et mes écolières sont tres attentifs et très studieux. 11. Elles ne sont pas très studieuses. 12. Leurs habillements sont superbes. 13. Sommes-nous le quinze du mois? 14. Non, nous ne sommes que le onze. 15. Avez-vous la première place ou la deuxième? 16. J'ai la première et mon frère a la deuxième. 17. Il n'est pas encore deux heures. 18. Est-il une heure et demie? 19. Il est midi et quart ou midi et demi. 20. Il est huit heures moins un quart.

Key to Exercise 11

1. I have no reason to do it. 2. Have you the objects asked for? 3. I have none of them. 4. Several people have told me that. 5. Other countries, other manners. 6. Have you seen any one in the town? No one. 7. They will have reasons of some sort. 8. The State, I am the State. 9. It was he that I saw here. 10. I love this woman, and I am loved in return. 11. Will you still have some pears to-morrow? 12. Yes, sir, I shall have plenty. 13. He has but a parasol. 14. Have you my books or your own? 15. Is that meat better than this? 16. This is better than that. 17. Has not your sister a white dress? 18. No, she has not. 19. Have you not got them? 20. No, sir, we have not got them.

Key to Exercise 12

1. Avez-vous de bons chevaux? 2. Oui, monsieur, j'en ai. 3. N'avez-vous pas mes plumes? 4. Non, monsieur, je n'a pas vos plumes, j'ai les miennes. 5. Avez-vous mes livres ou les vôtres? 6. Je n'ai ni les vôtres ni les miennes. 7. Votre frère n'a-t-il pas de souliers noirs? 8. Non, il n'en a pas. 9. Qui en a un? 10. Qui n'en a pas? 11. Le boucher n'a-t-il pas de la viande fraîche? 12. Il en a beaucoup. 13. Il n'en a guère. 14. Ce monsieur a-t-il une bonne plume d'acier ou une belle plume d'or? 15. Il en a une d'acier et nous en avons une d'or. 16. Combien de poires avez-vous? 17. Nous en avons assez. 18. Il a quelque chose de bon et de mauvais. 19. Il n'a rien de bon. 20. Vous n'avez guère de pêches.

E. A. B.

GERMAN.—V

Verbs.—There are two voices, the Active and the Passive. They correspond to the English Active and Passive voices, but the latter, it should be noted, is used less frequently in German.

There are three moods in German—the Indicative, which is used for making a statement; the Imperative, which is used for issuing a command; and the Conjunctive, which is used chiefly in subordinate clauses, but also in principal clauses under certain conditions which we shall examine later.

There are three tenses or times—the Present, the Past, and the Future. In addition to the simple tenses there are also compound (or perfect) tenses.

There are three auxiliary verbs, **haben,** *to have*, **sein,** *to be*, and **werden** *to become.* When used as auxiliaries these verbs forgo their own proper meaning entirely, and simply help to form certain tenses of other verbs.

Haben followed by the Past Participle of the verb that is being conjugated is used to form the Perfect tenses of most verbs.

Sein followed by the Past Participle of the verb is used to form the Perfect tenses of verbs of motion, and of certain other intransitive verbs, with which the student will grow familiar gradually.

Werden followed by the Infinitive of the verb conjugated is used to form the Future tenses and certain alternative forms of the tenses of the Conjunctive mood.

Werden followed by the Past Participle of the verb conjugated is used to form all the tenses of the Passive voice.

As in English, only transitive verbs, i.e. such verbs as require an object, have a Passive voice.

Verbs have a Present Infinitive, e.g. *to love;* a Perfect Infinitive, e.g. *to have loved;* a Present Participle, e.g. *loving;* and a Perfect or Past Participle, e.g. *loved.*

We shall now give the simple tenses of the verb werden.

Present Infinitive werd-**en** (vayrdən)
Present Participle werd-**end** (vayrdənt)
Past Participle **ge**-word-**en** (gəvordən)

Indicative

Present

ich werd-**e**, *I become.*
du wir-**st** (virst)
er wird (virt)
wir werd-**en**
ihr werd-**et**
Sie werd-**en**
sie werd-**en**

Past or Preterite

ich wurd-**e** (voordə) or ward (vart), *I became.*
du wurd-**est** or wardst
er wurd-**e** or ward
wir wurd-**en**
ihr wurd-**et**
Sie wurd-**en**
sie wurd-**en**

Future

ich werd-**e** werden, *I shall become.*
du wir-**st** werden
er wird werden
wir werd-**en** werden
ihr werd-**et** werden
Sie werd-**en** werden
sie werd-**en** werden

Imperative

werd-**e**, *become* (thou).
er werd**e**, *let him become.*
werd-**en** wir, *let us become.*
werd-**et**, *become* (you).
werd-**en** Sie
werd-**en** sie, *let them become.*

Conjunctive

Present

ich werd-**e**, *I may become.*
du werd-**est**
er werd**e**
wir werd-**en**
ihr werd-**et**
Sie werd-**en**
sie werd-**en**

Past

ich würd-**e** (vürdə), *I might become.*
du würd-**est**
er würd-**e**
wir würd-**en**
ihr würd-**et**
Sie würd-**en**
sie würd-**en**

Future

ich werd-**e** werden, *I shall become.*
du werd-**est** werden
er werd-**e** werden
wir werd-**en** werden
ihr werd-**et** werden
Sie werd-**en** werden
sie werd-**en** werden

Alternative form of Past Conj., sometimes called Conditional

ich würd-**e** werden, *I should become.*
du würd-**est** werden
er würd-**e** werden
wir würd-**en** werden
ihr würd **et** werden
Sie würd-**en** werden
sie würd-**en** werden

The forms ward and wardst are the original ones, but they are now used only in rather elevated style.

The Future tenses are formed by the Pres. Ind. and Conj. of the verb werden followed by the Pres. Inf. of the verb that is being conjugated.

The alternative form of the Past Conj. is formed by the Past Conj. of werden followed by the Pres. Inf. of the verb that is being conjugated.

Henceforth we shall give only the first person of these tenses, as the student can easily form the rest of the tenses himself.

Present Infinitive sein, *to be.*
Present Participle sei-**end** (zyənt), *being.*
Past Participle **ge**-wes-**en** (gəvayzən), *been*

Indicative

Present

ich bin, *I am.*
du bist
er ist
wir sind
ihr seid (zyt)
Sie sind
sie sind

Past or Preterite

ich war, *I was.*
du war-**st**
er war
wir war-**en**
ihr war-**t**
Sie war-**en**
sie war-**en**

Conjunctive

Present

ich sei (zy), *I may be.*
du sei-**est** (zyəst)
er sei
wir sei-**en** (zyən)
ihr sei-**et** (zyət)
Sie sei-**en**
sie sei-**en**

Past

ich wär-**e** (vayrə), *I might be.*
du wär-**est**
er wär-**e**
wir wär-**en**
ihr wär-**et**
Sie wär-**en**
sie wär-**en**

Future	*Future*
ich werd-**e** sein, *I shall be.*	ich werd-**e** sein, *I shall be.*

Alternative Form of Past
ich würd-**e** sein, *I should be.*

Imperative

sei, *be* (thou).	seid, *be* (you).
sei er, *let him be.*	sei-**en** Sie, *be (you).*
sei-**en** wir, *let us be.*	sei-**en** sie, *let them be.*

Present Infinitive	hab-**en**, *to have.*
Present Participle	hab-**end** (hahbənt), *having.*
Past Participle	**ge**-hab-**t** (gəhapt), *had.*

Indicative Present	*Conjunctive Present*
ich hab-**e**, *I have.*	ich hab-**e**, *I may have.*
du has-**t**	du hab-**e-st**
er ha-**t**	er hab-**e**
wir hab-**en**	wir hab-**en**
ihr hab-**t**	ihr hab-**et**
Sie hab-**en**	Sie hab-**en**
sie hab-**en**	sie hab-**en**

Past or Preterite	*Past*
ich hat-**te**, *I had.*	ich hät-**te** (hette), *I might have.*
du hat-**test**	du hät-**test**
er hat-**te**	er hät-**te**
wir hat-**ten**	wir hät-**ten**
ihr hat-**tet**	ihr hät-**tet**
Sie hat-**ten**	Sie hät-**ten**
sie hat-**ten**	sie hät-**ten**

Future	*Future*
ich werd-**e** haben, *I shall have.*	ich werd-**e** haben, *I shall have.*

Alternative Form of Past
ich würd-**e** haben, *I should have.*

Imperative

hab-**e**, *have* (thou).	hab-**et**, *have* (you).
hab-**e** er, *let him have.*	hab-**en** Sie, *have* (you).
hab-**en** wir, *let us have.*	hab-**en** sie, *have, let them have.*

The student should note that the tense endings vary little, only the Conj. terminations are in some cases fuller than those in the Ind. Thus, Ind. du warst, Conj. du wärest; wirst and wird are contractions of wirdst and wirdt respectively, and hast and hat of habst and habt (see the Pres. Ind. of these verbs).

Sein is very irregular, being formed from three different roots which appear in the forms **sein, bin** and **war,** which latter is the same root as in gewesen.

Before proceeding any farther the student should thoroughly learn the above auxiliary verbs. They are, of course, in such constant use that a ready familiarity with them is absolutely essential.

VOCABULARY

freund (froynt), s.m.2, *friend.*
lang (langk), *long.*
weil (vyl), *because.*
gar'nicht (gahr'nicht), *not at all.*
Geschäfts'führer (gəshefts'fürər), *man of affairs.*
im Stande (shtandə), *able.*
dasz (dass), conj., *that.*
schulden (shuldən), *to owe.*
kommen (kommən), *to come.*
Quittung (kwittungk), w.f., *receipt.*
lieber (leebər), *rather.*
reich (rych), *rich.*
krank (krank), *ill.*
erstaunt (ayrshtownt), *astonished.*
einige (yinigə), *some.*
besuchen (bəsookən), *to visit.*
wagen (vahgən), *to dare.*
bezahlen (bətsahlən), *to pay.*
mehr (mayr), *more.*
bitten (bittən), *to ask, beg.*
um (um), prep., *in order to.*
verlie'ren (fayrlee'rən), *to lose.*
als (als), *than.*

Exercise 16

Freunde und Geld.

Ein reicher Mann war lange[1] Zeit krank, und er war erstaunt weil einige seiner[2] Freunde ihn garnicht besuchten.[3] Da[4] sagte ihm sein Geschäftsführer[5], „Sie wagen nicht zu kommen weil[6] sie Ihnen Geld schulden und nicht im Stande[7] sind[8] es zu bezahlen."[9] Darauf antwortete der Mann: „Sagen Sie ihnen daß[10] sie mir nichts mehr schulden und daß[10] ich sie bitte zu mir zu kommen um[11] ihre Quittungen zu holen. Ich verliere lieber mein Geld als[12] meine Freunde."

NOTES:—

(1) lange Zeit: duration of time is expressed by the acc. (2) seiner Freunde: this is a partitive use of the gen., i.e. some of his friends. (3) weil . . . besuchten: this is a dependent clause introduced by weil and hence the finite verb besuchten is placed at the end. (4) da sagte ihm: the sentence begins with the adverb da, and hence the normal order is inverted and the verb precedes the subject. (5) Geschäftsführer: this is a compound noun made up of the gen. of the noun Geschäft, s.n.2, meaning business, and the noun Führer, s.m.1, meaning one who leads or conducts. The compound therefore means a conductor of business. Such compounds are very common in German, and they have the gender and declension of the second component. (6) weil . . . schulden: see (3). (7) im Stande sein means literally to be in a position (to do a thing). (8) sind: for the position of the verb, see note (3); the clause is co-ordinate with weil . . . schulden. (9). bezahlen: the infinitive, as usual, is placed at the end. (10) daß . . . schulden and daß . . . bitte: see note (2). (11) um, meaning in order to, is always followed by an infinitive with zu; for position of infinitive, see note (9). (12) als is always used after a comparative (lieber).

Exercise 17

1. Account for the cases of the following words in Exercise 16: — ihn, Ihnen, Stande, Quittungen, Freunde.

2. Translate into German:—This woman was ill for a long time and she was rich. They were aston-

ished because I did not visit them. That man was not in a position to come. Tell her that I am ill. He says that I lose my money. They will be tired. You will have many friends. She had the books which they fetched.

Comparison of Adjectives.—The comparative and superlative are formed by adding **er** for the former and **st** or **est** for the latter. Most monosyllabic adjectives modify the stem vowel where modification is possible. Thus: alt, *old;* älter (eltər), *older;* ältest (eltəst), *oldest.*

These comp. and superl. forms are subject to declension in exactly the same way as the positive, e.g. ein alter Mann, ein älterer Mann, der älteste Mann.

Exceptions: monosyllables with the stem vowel **au** never modify.

The commonest monosyllables that do not modify are:

Brav (brahf), *brave, good.*	rasch (rash), *quick.*
bunt (bunt), *variegated, gay.*	stolz (shtolts), *proud.*
falsch (falsh), *false.*	voll (foll), *full.*
froh (froh), *joyful.*	wahr (vahr), *true.*
lahm (lahm), *lame.*	zahm (tsahm), *tame.*

Adjectives ending in **el, en, er** usually drop the e of the termination in the comparative; thus, eitel (ytəl), *vain,* eitler.

Adjectives ending in a sibilant (**s, sz, sch, z**) usually take the superlative ending **est;** thus, arm, ärmer, ärmst; but heisz (hyss), *hot,* heiszer, heiszest.

The superlative when used predicatively or adverbially, that is, when not followed by a noun expressed or understood, has a fixed form with the prep. **an** and the def. art.; e.g. am schönsten, *the most beautiful.* Thus: das ist das schönste Haus, but dieses Haus ist am schönsten, and das klingt am schönsten, *that sounds the most beautifully.*

Irregular Comparisons

Positive	*Comparative*	*Superlative*
gut (goot). *good.*	besser (bessər).	der, die, das beste (bestə).
hoch (hoh*k*), *high.*	höher (höhər).	der, die, das höchste (höchstə).
nah (nah), *near.*	näher (nayhər).	der, die, das nächste (nay*ch*stə).
viel (feel), *much.*	mehr (mayr).	der, die, das meiste (mystə).
wenig (vay-nik), *little.*	minder (mindər).	der, die, das mindeste (mindestə).

All these have the superl. forms am besten, etc.; wenig has a regular comp. and superl. weniger, der wenigste and these are more common in modern German than the irregular ones. Grosz (grohss), *big, great,* is an exception in that it makes the superl. der gröszte (grösstə), instead of, as one would expect, gröszeste.

VOCABULARY

gnädig (gnaydig), *gracious.*
recht (re*ch*t), *right.*
Jawohl' (yahvohl'), *yes.*
Vor'stellung (fohr'shtellungk), w.f., *performance.*
Stück (shtück), s.n.2, *piece.*
Sie sollten (zolltən), *you ought.*
ich kann (kann), *I can.*
da (conjunction), *as, since.*
reisen (ryzən), *to travel.*
wünschen (vünshən), *to wish.*
aufwie'dersehen (owfvee'dərzayən), *till we meet again* (French *au revoir*).
danke schön, *thank you very much.*
Thea'ter (tayah'tər), s.n. 1, *theatre.*
hoffen (hoffən), *to hope.*
mäszig (mayssik), *moderate, medium.*
Schau'spieler (show'shpeelər), s.m.1, *actor.*
O'per (oh'pər), w.f., *opera.*
leider (lydər), *alas, unfortunately.*
nach Hause, *home* (when motion is intended).
Schade (shahdə), w.m., *pity.*
Reise (ryzə), w.f., *journey.*

Unterhaltung

Guten Tag gnädige[1] Frau. Wie geht es Ihnen?
Danke ſchön,[2] es geht mir recht gut.[3]
Waren Sie geſtern Abend im Theater?
Jawohl, ich war mit meiner Schweſter dort.
Ich hoffe daß die Vorſtellung eine gute war.
Sie war mäßig; das Stück war ſchon[4] gut, aber die Schauſpieler waren weniger gut.
Sie ſollten heute Abend in die Oper gehen.
Das kann ich leider nicht, da ich heute noch[5] nach Hauſe reiſe.
Das iſt Schade. Ich wünſche Ihnen eine glückliche Reiſe. Aufwiederſehen.
Aufwiederſehen mein Herr.[6]

NOTES:—
(1) gnädige Frau (literally, gracious lady) is the proper way for any gentleman to address a lady unless he is very friendly with her. It is also used by a younger lady in addressing an older one. (2) ſchön is here equivalent to very much. (3) recht gut: literally, right well. (4) ſchon: the use of this word in this and similar constructions is idiomatic and almost impossible to render in English; the nearest one can get to it is, the piece indeed was good, but, etc. (5) noch is best left untranslated in English. (6) mein Herr is sir, whereas ein or der Herr is a (or the) gentleman.

Key to Exercise 10

1. Was sagte er Ihnen? 2. Die Gepäckträger bringen unser Gepäck. 3. Was kostete Ihr Hut? 4. Meine Frau kaufte zwei Hüte. 5. Wo ist die Zeitung? 6. Sie ist auf dem Tisch. 7. Holte der Diener ihr Gepäck? 8. Sie hatte kein Gepäck. 9. Was hören Sie? 10. Ich höre einen Lärm. 11. Was suchten Sie? 12. Wir suchten die Kinder im Garten. 13. Wo ist der Bahnhof? 14. Er ist in der X Strasze. 15. Wer wohnt hier? 16. Warum holten Sie nicht unser Gepäck? 17. Jenes Mannes Bücher sind nicht hier.

M. A. L.

Continued from page 427.

GEOGRAPHY:

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LAND FORMS AND THEIR ORIGIN.—I

If we examine a globe or model of the Earth, it will easily be perceived that there is more of the Earth's surface covered with water than with land. As a matter of fact, only about 29 per cent. of the surface of the globe is dry land. If we examine the globe still further, we notice that the land is grouped more or less round the North Pole, and, in fact, if we so arrange the globe that France is uppermost and look down upon it, a very large proportion of the surface that is then visible is seen to be land. If, on the other hand, we examine the other hemisphere, it is seen to be very nearly all water, the land masses being quite inconspicuous.

The main masses of land are called *continents*. They are conventionally considered as being five in number, viz.: Europe, Asia, Africa, America and Australasia. Virtually, Europe and Asia are one continent, Europe forming a kind of western peninsula of Asia. America, however, should, strictly speaking, be considered as two continents, as North and South America are almost separated from each other by the Gulf of Mexico and the Caribbean Sea.

Mountains and Plains

The average height of the entire surface of the land of the Earth is estimated at about 2,300 feet above the level of the sea, but it varies between the height of such mountains as the Himalayas, which culminate in Mt. Everest, about five miles high, and depressions below sea level such as are found in the neighbourhood of the Caspian Sea, where the land is one hundred feet lower than the sea.

The high parts of the land form either (*a*) plateaux or tablelands, which may, however, be cut up by river valleys and which slope more or less gradually to lower levels, or (*b*) mountain chains.

Among the plateaux of the Earth may be mentioned, for the sake of example, the Spanish Plateau in Europe, Thibet in Asia, Bolivia in S. America. Among mountain chains, which are the more obvious forms of high land, we may notice here in Europe the Alps and the Pyrenees, in Asia the Himalayas, in America the Rocky Mountains and the Andes.

The low parts of the land form plains, and these occupy a much greater area of the Earth than the high parts. Among these we will notice the Great Lowland Plain of Europe, the Plain of China in Asia, the Selvas of the Amazon in S. America.

River Erosion

We will now consider the chief of the various natural agencies which are instrumental in carving the land masses of the Earth into the forms and shapes that we see.

Rain falling on high ground tries to run downhill. If it is unable to sink into the ground, it flows along the surface, always seeking lower levels. If it does sink into the ground, it permeates the soil until it reaches a layer that is impervious. Then it flows underground along the top of this impervious layer until at some lower level it gains the surface as a spring, at some place where this impervious layer forms an outcrop. The water from such springs, together with runnels of surface water, unite to form a stream, and by the union of streams is formed a river.

The water of a stream or river always carries with it, both dissolved and held in suspension, a large amount of the surface material of the ground over which it has been flowing. This material has a great effect on the work done by a river, which will be mentioned later. A river empties itself into the sea or into another river at its mouth. The sides of a river are called its banks, the "right bank" being that which is on the right-hand side when looking in the direction in which the water is flowing.

It is in the upper portion of its course that a river does the greatest part of its work in

wearing away the rocks over which it flows. This is chiefly effected by the rubbing action of matter held in suspension, and is greatest where the current flows fastest, that is, in the steepest parts. The result of this is that a river continually cuts back its own source and thus lengthens itself. This, of course, lessens the slope of the stream until it is unable to do any more work of erosion.

Examination of a globe will show [that land is grouped more or less round the North Pole and that—

One of the most remarkable examples of erosion is seen at Niagara, where the river has worn out a deep gorge about seven miles in length, which is even now being lengthened at a rate which has been computed at over two feet a year. At the same time that a river is cutting back its own source the tributary streams are in like manner wearing back the rocks over which they flow, and thus the river-valley becomes V-shaped in section.

The Nile Delta

As the river continues its course towards the sea the work of erosion becomes less and less, and ultimately the matter held in suspension will be deposited as the current grows slower and slower. Typically, this may form a *delta*, which is a triangular-shaped deposit of alluvium at the river mouth.

This is illustrated in the case of the Nile. In some cases the delta extends far out into the ocean, and thus a town which was originally a port on the sea may be, in the course of centuries, separated from it by some miles, as in the case of Adria, in Italy, once a flourishing sea-port but now 20 miles inland at the head of the delta of the Po.

Rivers and Lakes

Lakes are hollows in the land surface which have become filled with water. The largest fresh-water lake in the world is Lake Superior, in N. America, which is of about the same area as the whole of Ireland. Lakes are found of every size, ranging from this huge sheet of water to the smallest pool that can be seen anywhere in the country. Lakes may be fresh or salt; the latter occur chiefly in rainless districts where there is no outlet to the sea. The Dead Sea, in Palestine, is an example of he latter kind.

Lakes have arisen in various ways. To volcanic action we owe the *crater lakes* such as are found in the Auvergne region in France. Landslips have dammed valleys and have formed lakes; or a glacier may have deposited its moraine (see below) across a valley and thus formed a dam, the resulting hollow becoming filled with water by a

—the Southern hemisphere is nearly all water, land masses being quite inconspicuous.

stream. Hollows may have been eroded by the action of ice; and lastly we may mention that rivers form lakes by the gradual solution of limestone through lateral erosion and the subsidence or settling down of the earth owing to the solution of limestone rocks beneath the surface.

Probably the most remarkable lake system in the world is that of the basin of the St.

Lawrence river in N. America, where there is a chain of five huge lakes.

Ice and snow are both powerful agents in forming the face of the Earth. One method of the action of ice is but disintegration of the rocks themselves. When water which has percolated into the crevices of a rock freezes, the expansion caused thereby makes the crevice larger and wider, and may split up the rock into fragments, thus hastening its gradual breaking up. But the most noticeable effects of ice action took place many years ago, although to a certain extent they are still at work.

In bygone days a very large portion of the Earth's surface was covered with snow and ice. It is true that geologically speaking the Ice Age or Glacial Epoch is comparatively recent, though judging from the ordinary standpoint of the life of man it is almost inconceivably remote. During the Glacial Epoch much work was done on the Earth's surface by glacier action, and can be studied to-day by reference to the Alps.

At a certain height in all lofty mountains we reach a point above which the snow never melts. This height is known as the snowline, and, as we should expect, varies in height above the sea level in different latitudes, getting continually higher as we approach the Equator. Ben Nevis, for instance, in Scotland, is just below the snowline, but if it were 1,000 feet higher it would be above it, as the snowline is in that latitude some 4,500 feet high. When we get to the Equator, however, we find that Quito, in Ecuador, although 9,350 feet above the sea, is yet far below the snowline, which in that district is over 18,000 feet high.

Glaciers are formed from the snow above the snowline. This snow continually accumulating and never melting exercises very great pressure on the lower parts of itself, and losing its loose and granular texture, forms solid ice. This ice moves continually down the valleys in just the same way as a river flows, though its rate of flow is very small compared with the rate of flow of a river. The second volume of this work opens with a plate showing the action of glaciers.

NIAGARA FALLS.

One of the most remarkable examples of erosion in the world. The river has worn out a deep gorge about seven miles in length, which is still being lengthened at a rate of over two feet a year.

A river, for example, if moderately rapid, flows some two miles an hour, but a glacier varies from two to perhaps fifty or sixty feet, in very rapid cases, in the twenty-four hours. It is noticed, too, that just as a river flows more quickly in the centre of the stream, so does a glacier. The friction between the sides and bottom of the glacier and the rocks over which it is moving, slows the rate of flow considerably.

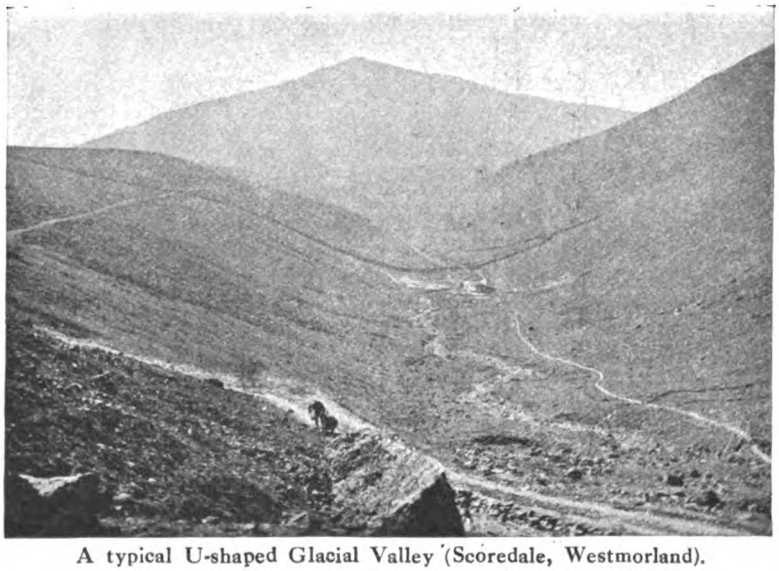
A river, as we have seen, carries in suspension solid matter which gradually wears away or erodes the land over which it flows. In the case of a glacier the action, though somewhat similar, is not quite the same. If we look at a glacier, or study a good photo-

graph of one, we shall see that along the edges there is a more or less definite line of fragments that have been broken off from the rocks on either side. These are called moraines. If two glaciers moving down two separate valleys unite and form one larger glacier in the same way as two rivers may come together to make a larger stream, the two adjacent lines of rock fragments, that is, the right-hand moraine of one and the left-hand moraine of the other, will unite to form a median moraine. Thus the combined glacier will now have a median moraine and two lateral moraines.

A typical V-shaped River Valley in the Moorland of the Longmynd, Shropshire.

Now this moraine-stuff may fall down a crack or crevasse in the ice which may have been formed if the glacier passes over uneven ground, and will be found all along the under surface of the glacier. There will thus be a certain amount of rock which is slowly carried down with the glacier as it moves along. This, under the great pressure of the weight of ice, acts as a huge grooving instrument, and the rocks below will be worn away, showing that most characteristic scratched, or striated, aspect which is known as "glaciated." Glaciated rocks left from the passage over them in the Great Ice Age of huge glaciers are seen in many parts of the British Isles.

Glaciated valleys show a very typical form, being U-shaped in section instead of V-shaped, which is the usual form of the valley that has been formed by the action of rivers only. And further, a river which has been deepened by ice action shows a peculiarity in having its tributary valleys high up on the sides of the main valley and from which the streams reach the main valley with a leap, either in a distinct waterfall or a series of cascades; that is to say, there is a very noticeable difference of level between the beds of the main and the side streams. Such high lateral valleys are called "hanging valleys," and are associated with a kind of shelf, called in Switzerland an *alp*, all along each side of the main valley.



A typical U-shaped Glacial Valley (Scoredale, Westmorland).

It is probable that the original valley floor as left by the action of the streams that formed it was at about the level of this shelf and that the glacier has grooved out and deepened the valley below. If by reason of a rise in temperature a glacier becomes smaller, some of the rock fragments may be left behind. Such fragments, often "perched" in curious positions, are known as erratics. C. J. S.

Continued from page 437.

MATHEMATICS:

Contributor: — ARITHMETIC, ALGEBRA, GEOMETRY, CO-ORDINATE GEOMETRY, TRIGONOMETRY, MECHANICS, MENSURATION, ETC.
(M. A. Lewenz, M.A. [Lond.]).

ARITHMETIC.—VIII

71. Addition and Subtraction of Decimals.

—To add 3·175, 52·01, 6·1, 72 and ·0015. If we convert these into vulgar fractions, we get

$$\frac{3175}{1000} + \frac{5201}{100} + \frac{61}{10} + 72 + \frac{15}{10000}$$

(reducing to the lowest common denominator)

$$= \frac{31750}{10000} + \frac{520100}{10000} + \frac{61000}{10000} + \frac{720000}{10000} + \frac{15}{10000}$$

$$= \frac{1332865}{10000} = \mathbf{133{\cdot}2865.}$$

Now we should obtain exactly the same result if we place each of the numbers in a column, taking care that the decimal points in each case be one under the other, and placing the decimal point in the sum under the decimal point above. We have then, omitting unnecessary cyphers, the following:

```
  3·175
 52·01
  6·1
 72·
  ·0015
133·2865
```

The same explanation of the operations of addition and subtraction as we gave for integers, applies also to decimals (the student can easily prove this himself). In subtraction, therefore, as in addition of decimals, we proceed as if we were dealing with integers. Care must, however, be taken not to shift the decimal points.

In subtracting, as many noughts as are needed may be added to the *right* of the decimal, since these do not affect its value.

Thus to subtract ·643 from 2·7 we proceed thus:

```
 2·700
  ·643
 2·057
```

Exercise 23

Add together:

(1) ·213, ·054, 10·01, 13·859, 70·00052, 117·854321.

(2) ·559, 55·999, 1·090003, 721·854, 9000·09876.

(3) 1·000001, 7·77777, 98·7654321, 12·3456789.

Find the difference between:

(4) 3·459 and 1·002; ·583 and ·216; 6·5555 and 7·8513.

(5) 1·000001 and ·999999; 7·851436 and 3·9753104.

(6) ·9 and ·00009; 7·10001 and 9·200001; 6·54321 and 4·999999.

(7) ·8 and ·02101; 8·9805 and 7·3542105; 16·000905 and 8·901.

(8) 6·142785 and ·375428; 4·01625 and ·125.

72. Multiplication of Decimals

EXAMPLE:—

(1) Multiply 4·73 by ·13

$$4{\cdot}73 \times {\cdot}13 = \frac{473}{100} \times \frac{13}{100} = \frac{6149}{10000}$$

$$= \mathbf{{\cdot}6149.}$$

```
  473
   13
 1419
  473
 6149
```

(2) $4{\cdot}73 \times {\cdot}0013 = \frac{473}{100} \times \frac{13}{10000}$

$$= \frac{6149}{1000000} = \mathbf{{\cdot}006149.}$$

In each case the number of decimal places in the product equals the number of cyphers in the denominator which equals the sum of the number of decimal places in the multiplier and in the multiplicand.

Thus in

(1) the number of decimal places = 2 + 2 = 4,

and in

(2) the number of decimal places = 2 + 4 = 6.

Hence we have the following rule: Multiply decimals together as if they were integers, and then place the decimal point in the product so that the number of decimal places in the product equals the sum of the number of places in the multiplier and the multiplicand.

When there are cyphers at the end of the product, these must be taken into account in placing the decimal point.

EXAMPLE:—

Multiply 7·5402 by ·0036.

```
 7·5402
  ·0036
452412
226206
2714472
```

Now the number of decimal places = 4 + 4 = 8.

∴ We must place a cypher before the product since there are only 7 places in the product.

Thus $7{\cdot}5402 \times {\cdot}0036 = \mathbf{{\cdot}02714472.}$

Exercise 24

Multiply together:

(1) 3·7 by 4·2; 3·7 by 42; ·37 by ·42; and 0·37 by ·042.

(2) 529 by ·529; 52·9 by 52·9; ·529 by ·0529.

(3) 2·0003 by 1·004; 21·003 by ·04; 7·568 by 3·417.

(4) 1·25 by ·8; 12·5 by 8; ·125 by ·008.

(5) Find the continued product of:
$5 \times {\cdot}5 \times {\cdot}05 \times {\cdot}005 \times {\cdot}0005.$

(6) Find the continued product of:
$6{\cdot}824 \times 7{\cdot}5 \times {\cdot}125 \times 3{\cdot}12 \times 100000.$

73. (a) To divide a decimal by a whole number.

EXAMPLE :—

Divide 8·136 by 113.

$$8{\cdot}136 \div 113 = \frac{8136}{10{\cdot}00} \div 113 = \frac{8136}{1000} \times \frac{1}{113} = \frac{72}{1000} = \mathbf{{\cdot}072.}$$

```
      72
113)8136
     226
     ...
```

73. (b) To divide a decimal by a decimal.

EXAMPLE :—

Divide 8·136 by 1·13

$$8{\cdot}136 \div 1{\cdot}13 = \frac{8136}{1000} \div \frac{113}{100} = \frac{8136}{1000} \times \frac{100}{113} = \frac{8136}{113} \times \frac{100}{1000} = 72 \times \frac{1}{10} = \frac{72}{10} = \mathbf{7{\cdot}2.}$$

As will be seen by the above example, we practically reduce case (*b*) to case (*a*) by multiplying the dividend and the divisor by a power of 10, which will make the divisor a whole number.

The number of decimal places in the quotient is equal to the number of cyphers in the denominator of the quotient, and this equals the number of cyphers in the denominator of the dividend minus the number of cyphers in the denominator of the divisor.

In case (*a*) where the divisor is a whole number, the number of decimal places in the quotient = the number of cyphers in the denominator of the dividend = the number of decimal places in the dividend = 3.

In case (*b*) the number of decimal places in the quotient = the number of cyphers in the denominator of the dividend − the number of cyphers in the denominator of the divisor = the number of decimal places in the dividend − the number of decimal places in the divisor = 3 − 2 = 1.

In practice, then, we proceed as follows:

EXAMPLES :—

(1) 31·5 ÷ ·126.

31·5 ÷ ·126 = 31500 ÷ 126 (multiplying both by 1000 to make the divisor a whole).

```
   250
126)31500
    63
    ....
```

Answer **250.**

(2) 23·74 ÷ 6·4 = 237·4 ÷ 64.

```
   3·709375
64)237·400000
   454
    600
     240
      480
       320
       ...
```

We may add as many noughts as are needed to complete the division, to the right of the dividend, since noughts added to the right do not affect the value of a decimal.

Answer **3·709375.**

The position of the decimal point in the dividend indicates the position of the decimal point in the quotient. Very often only a certain number of places in the quotient are required. If we wished to obtain the above result correct to three places of decimals, it would be 3·709, for 3·709 is more nearly equal to 3·709375 than is 3·710.

But if we wanted the result correct to four places of decimals it would be 3·7094, for 3·7094 is more nearly equal to 3·709375 than is 3·7093. (The student can prove the truth of this by finding the differences in each case.)

Exercise 25

Divide :

(1) 17·8 by 2 ; (2) 1·896 by 8 ; (3) 72·15 by 5 ; (4) 6·485 by 25 ; (5) 14·72 by ·16 ; (6) 2·03 by 2·9 ; (7) ·001827 by ·029 ; (8) ·5976 by ·00006 ; (9) ·00945 by 1350 ; (10) ·01001 by 1·3 ; (11) ·0005 by 5, by ·5, by ·025, by ·125 and by ·00625 ; (12) ·01 by 200, by 40, by ·8, by ·016 and by ·00032.

Find correct to four places of decimals :

(13) 7·413 ÷ 8·9 ; (14) 1·7984 ÷ ·187 ; (15) 12 ÷ ·13 ; (16) ·0179 ÷ ·007 ; (17) 21·0015 ÷ ·0042 ; (18) 7·813 ÷ 5·07 ; (19) 4004 ÷ 198761 ; (20) 378 ÷ 5948723.

74. To express a vulgar fraction as a decimal.—Since a vulgar fraction may be regarded as the quotient of the numerator divided by the denominator, we may always express such a fraction to any degree of accuracy required, by dividing the numerator by the denominator, affixing as many cyphers as required to the right of the decimal point as in ordinary division. Some vulgar fractions can be expressed exactly as decimals.

EXAMPLE :—

Express $\frac{1}{27}$ as a decimal correct to 4 significant figures.

```
    ·037037
27)1·000000
   190
    100
     190
      10
```

Cyphers immediately to the right of the decimal point are not significant figures, and as we have one cypher to the right of the decimal point, we want our result correct to *five* decimal places. In order to insure sufficient accuracy we must work to the 6th place.

$\frac{1}{27}$ = ·037037 = **·03704** to four significant figures.

75. All fractions should be reduced to their lowest terms before being converted into decimals. Any fraction having as a denominator any power of 2 or of 5 can be immediately reduced to a decimal.

For $2 \times 5 = 10$

$2^2 \times 5^2 = 10^2$

$2^3 \times 5^3 = 10^3$ and so on.

Hence, to reduce such a fraction to a decimal we need only multiply numerator and denominator by such powers of 2 or 5, or both, which will make the powers of 2 and 5 in the denominator the same.

Thus we get as denominator a power of 10, and can write the fraction as a decimal.

EXAMPLE :—

Express $\frac{9}{24}$ as a decimal.

$$\frac{9}{24} = \frac{3}{8} = \frac{3}{2^3} = \frac{3 \times 5^3}{2^3 \times 5^3} = \frac{3 \times 125}{10^3} = \frac{375}{1000}$$
$$= \cdot 375.$$

Exercise 26

Convert the following vulgar fractions into decimals :

(1) $2\frac{1}{4}$; (2) $\frac{3}{4}$; (3) $\frac{5}{8}$; (4) $\frac{7}{25}$; (5) $\frac{13}{625}$; (6) $7\frac{319}{2045}$;
(7) $\frac{597}{2000}$; (8) $\frac{370}{1125}$; (9) $\frac{1}{1000}$; (10) $17\frac{9}{5120}$.

76. If any vulgar fraction, when reduced to its lowest terms, has a denominator containing any factors except 2 or 5, or powers of 2 or 5 ; or 2 and 5, or powers of 2 and 5, then the division of the numerator by the denominator will not give an exact result ; the quotient may be found to any degree of accuracy we please, but will never terminate.

However, if we continue long enough with the division, we shall find that some or all of the figures in the quotient are repeated over and over again, always in the same order. In other words, these figures recur. Such decimals are called *Recurring* or *Circulating Decimals.*

Suppose we try to express $\frac{1}{3}$ as a decimal.

$\frac{1}{3} = \cdot 33333 \ldots$

Again $\frac{1}{7} = \cdot 142857142857142857 \ldots$

Again $\frac{29}{225} = \cdot 128888 \ldots$

The notation we adopt is the following :—

(*a*) $\cdot\dot{3} = \cdot 3333 \ldots$

(*b*) $\cdot\dot{1}42857\dot{} = \cdot 142857142857 \ldots$

(*c*) $\cdot 12\dot{8} = \cdot 128888 \ldots$

(*d*) $\cdot 7964\dot{3} = \cdot 79643643 \ldots$

The figures which recur are called the *circulating period.*

A *pure* recurring or circulating decimal is one in which all the figures to the right of the decimal point recur.

A *mixed* recurring or circulating decimal is one in which the figures to the right of the decimal point do not begin to recur until after a certain number of figures.

Thus in the above (*a*) and (*b*) are *pure*, and (*c*) and (*d*) are *mixed* recurring decimals.

77. To express a pure recurring decimal as a vulgar fraction.

(1) Consider $\cdot\dot{6}$.

$\cdot\dot{6} = \cdot 66666 \ldots$

Multiply the decimal by a power of 10 which will place the decimal point at the end of the first period. In this case we should multiply by 10.

$\cdot\dot{6} \times 10 = 6 \cdot 6666 \ldots$

Now subtract the decimal in its unaltered form from each side of the above.

$\cdot\dot{6} \times 10 - \cdot\dot{6} = 6 \cdot 6666 \ldots - \cdot 666 \ldots$

then $\cdot\dot{6} \times (10 - 1) = 6$

i.e. $\cdot\dot{6} \times 9 = 6$.

Now divide by 9. Then we have

$\frac{\cdot\dot{6} \times 9}{9} = \frac{6}{9}$ i.e. $\cdot\dot{6} = \frac{6}{9} = \frac{\mathbf{2}}{\mathbf{3}}$.

(2) Consider $\cdot\dot{5}17\dot{3}$

$\cdot\dot{5}17\dot{3} = \cdot 51735173 \ldots$

This time we must multiply by 10000 to move the decimal point to the end of the first period.

Then $\cdot\dot{5}17\dot{3} \times 10000 = 5173 \cdot 51735173 \ldots$ proceeding as before.

$\cdot\dot{5}17\dot{3} \times 10000 - \cdot\dot{5}17\dot{3} = 5173 \cdot 51735173 \ldots$
$\qquad - \cdot 51735173 \ldots$

$\therefore \cdot\dot{5}17\dot{3} \times 9999 = 5173$

and (dividing by 9999)

$$\cdot\dot{5}17\dot{3} = \frac{\mathbf{5173}}{\mathbf{9999}}.$$

From the above we see that **a pure recurring decimal is equivalent to a vulgar fraction having as numerator the recurring period of the decimal, and as denominator the digit nine repeated as many times as there are figures in the recurring period.**

78. To express a mixed recurring decimal as a vulgar fraction.

(i) Consider $\cdot 1\dot{3}$.

$\cdot 1\dot{3} = \cdot 1333 \ldots$

Now if we first multiply by a power of 10 which will move the decimal point to the right of the non-circulating part of the decimal, and then multiply by a power of 10 which will move the decimal point to the end of the first period, and after that subtract the first from the second we shall get rid, as we did before, of the recurring period.

In this case we must first multiply by 10 and then by 100.

$\cdot 1\dot{3} \times 10 = 1 \cdot 3333 \ldots$

$\cdot 1\dot{3} \times 100 = 13 \cdot 3333 \ldots$

$\cdot 1\dot{3} \times 100 - \cdot 1\dot{3} \times 10 = 13 \cdot 3333 \ldots - 1 \cdot 3333 \ldots$

$\cdot 1\dot{3} \times (100 - 10) = 12$

$\cdot 1\dot{3} \times 90 = 12$

$\frac{\cdot 1\dot{3} \times 90}{90} = \frac{12}{90}$

$$\cdot 1\dot{3} = \frac{\mathbf{12}}{\mathbf{90}}.$$

(ii) Consider $\cdot 21\dot{5}0\dot{6}$.

We must multiply in this case by 100 and by 100000.

$\cdot 21\dot{5}0\dot{6} \times 100000 = 21506 \cdot 506506 \ldots$

$\cdot 21\dot{5}0\dot{6} \times 100 = 21 \cdot 506506 \ldots$

(subtracting) $\cdot 21\dot{5}0\dot{6} \times (100000 - 100) = 21485$

$\cdot 21\dot{5}0\dot{6} \times 99900 = 21485$

$\frac{\cdot 21\dot{5}0\dot{6} \times 99900}{99900} = \frac{21485}{99900}$

$$\therefore \cdot 21\dot{5}0\dot{6} = \frac{\mathbf{21485}}{\mathbf{99900}}.$$

(iii) Consider $\cdot 07\dot{4}2\dot{}$.

We must multiply by 10000 and by 1000.

$\cdot 07\dot{4}2\dot{} \times 10000 = 742{\cdot}2222\ldots$

$\cdot 07\dot{4}2\dot{} \times 1000 = 74{\cdot}2222\ldots$

(subtracting) $\cdot 07\dot{4}2\dot{} \times (10000 - 1000) = 668$

$$\frac{\cdot 07\dot{4}2\dot{} \times 9000}{9000} = \frac{668}{9000}$$

$$\therefore \cdot 07\dot{4}2\dot{} = \frac{668}{9000}$$

From the above we see that **a mixed recurring decimal is equivalent to a vulgar fraction having as numerator the difference between the number formed by the figures down to the end of the first period and the number formed by the figures of the non-recurring part; and having as denominator the digit nine repeated as many times as there are figures in the recurring period, followed by as many cyphers as there are figures in the non-recurring part.**

M. A. L.

ALGEBRA.—VIII

57. The case of a **binomial divisor** is of special interest.

Divide $p_0x^n + p_1x^{n-1} + p_2x^{n-2} + \ldots\ldots + p_{n-2}x^2 + p_{n-1}x + p_n$ by $(x - a)$

$x - a)\ p_0x^n + p_1x^{n-1} + p_2x^{n-2} + \ldots\ldots + p_{n-2}x^2 + p_{n-1}x + p_n\ (p_0x^{n-1} + (p_0a + p_1)x^{n-2} +$
$(p_0a^2 + p_1a + p_2)x^{n-3} \ldots\ldots$

$p_0x^n - p_0ax^{n-1}$

$(p_0a + p_1)x^{n-1} + p_2x^{n-2}$

$(p_0a + p_1)x^{n-1} - (p_0a^2 + p_1a)x^{n-2}$

$(p_0a^2 + p_1a + p_2)x^{n-2} + p_3x^{n-3}$

$(p_0a^2 + p_1a + p_2)x^{n-2} - (p_0a^3 + p_1a^2 + p_2a)x^{n-3}$

$(p_0a^3 + p_1a^2 + p_2a + p_3)x^{n-3}$

$\ldots\ldots$

The integral part of the quotient we see is

$p_0x^{n-1} + (p_0a + p_1)x^{n-2} + (p_0a^2 + p_1a + p_2)x^{n-3} + \ldots\ldots$

The coefficients of this integral part are obviously formed as follows:

The first is the first coefficient in the dividend.

The second is the sum of the previous coefficient multiplied by a and the second coefficient of the dividend.

The third is the sum of the previous coefficient multiplied by a and the third coefficient of the dividend.

The remainder, which in this case does not contain x, will obviously be obtained by multiplying the last coefficient of the quotient by a and adding the absolute term p_n of the dividend.

Hence the remainder will be

$p_0a^n + p_1a^{n-1} + p_2a^{n-2} + \ldots\ldots + p_{n-2}a^2 + p_{n-1}a + p_n$.

If we compare this with the dividend

$p_0x^n + p_1x^{n-1} + p_2x^{n-2} + \ldots\ldots + p_{n-2}x^2 + p_{n-1}x + p_n$

we see that

When an integral function of x is divided by x − a, the remainder is obtained by substituting a for x in the dividend.

This is known as the **Remainder Theorem.**

58. The above theorem may be looked upon as a test to find out whether a linear expression (one which is of the first degree in x) is a factor of any given integral function of x.

If such an expression is a factor, then, when the integral function is divided by it, the quotient will be integral and consequently the remainder will vanish.

Hence if $a, b, c \ldots\ldots$ be values of x for which any integral function of x vanishes, then $(x - a)$, $(x - b)$, $(x - c)$ $\ldots\ldots$ are factors of that function.

If $(x - a)^2$ be a factor of the function, then not only will the function itself vanish when a is substituted for x, but the quotient of the function divided by $(x - a)$ will also vanish when a is substituted for x. And similarly for higher powers.

EXAMPLE:—

Factorise $x^4 + x^3 - 10x^2 - 4x + 24 = A$. Since 2 is a factor of 24, we may try whether $(x - 2)$ is a factor of A.

Using the above theorem we find, if we substitute 2 for x, that the remainder is $16 + 8 - 40 - 8 + 24 = 0$,

Hence $x - 2$ is a factor.

We now proceed to find the quotient when A is divided by $x - 2$.

$$\frac{x^4 + x^3 - 10x^2 - 4x + 24}{x - 2}$$

$= x^3 + 3x^2 - 4x - 12 = B$.

Since 2 is also a factor of 12 we again find the remainder when 2 is substituted for x in B. The remainder is $8 + 12 - 8 - 12 = 0$.

$\therefore$ $x - 2$ is a factor of B.

Dividing B by $x - 2$ we find the quotient

$$\frac{x^3 + 3x^2 - 4x - 12}{x - 2} = x^2 + 5x + 6 = C.$$

C can be factorised by inspection:

$x^2 + 5x + 6 = (x + 2)(x + 3)$.

Hence $A = (x - 2)(x - 2)(x + 2)(x + 3)$

$= (x - 2)^2(x + 2)(x + 3)$.

Had we tried substituting 3 for x the remainder would not have vanished, but if we substitute -3 for x it would vanish, showing that $x - (-3) = (x + 3)$ is a factor.

59. Consider the integral function of the nth degree

$p_0x^n + p_1x^{n-1} + p_2x^{n-2} + \ldots\ldots + p_{n-1}x + p_n = A$

supposing A vanishes for n values of x, say $a, b, c, d \ldots\ldots$

Then $A = p_0(x - a)(x - b)(x - c) \ldots\ldots$

Now let us substitute for x some value, say λ,

where λ is different from each one of the n values $a, b, c, d \ldots\ldots$

Then since no one of the factors $(\lambda - a), (\lambda - b), (\lambda - c) \ldots$ equals 0, the continued product $p_0(\lambda - a)(\lambda - b)(\lambda - c) \ldots\ldots$ cannot vanish unless $p_0 = 0$.

But if $p_0 = 0$, then the original expression becomes $p_1x^{n-1} + p_2x^{n-2} + \ldots\ldots + p_{n-1}x + p_n = \mathrm{B}$, i.e. it becomes a function of the $(n-1)^{th}$ degree; and by similar reasoning we may show that B can only vanish for $(n-1)$ values of x, unless $p_1 = 0$, in which case B reduces to a function of the $(n-2)^{th}$ degree. And so on.

Hence **an integral function of the nth degree in x cannot vanish for more than n values of x unless the coefficients of all the powers of x are zero.** In the latter case the function will clearly vanish for all values of x.

60. Consider the two integral functions of the nth degree.

$p_0x^n + p_1x^{n-1} + p_2x^{n-2} \ldots\ldots + p_{n-1}x + p_n = \mathrm{A}$

$q_0x^n + q_1x^{n-1} + q_2x^{n-2} \ldots\ldots + q_{n-1}x + q_n = \mathrm{B}$.

If A be equal to B for more than n values of x, it follows that their difference

$(p_0 - q_0)x^n + (p_1 - q_1)x^{n-1} + (p_2 - q_2)x^{n-2} \ldots\ldots + (p_{n-1} - q_{n-1})x + (p_n - q_n)$

must vanish for more than n values of x, and $\therefore$ from § 59 it follows that the coefficients of all the powers of x must be equal to zero.

Hence $p_0 - q_0 = 0$, $p_1 - q_1 = 0$, $p_2 - q_2 = 0$, and so on, i.e. $p_0 = q_0$, $p_1 = q_1$, $p_2 = q_2$, and so on.

Hence **if two integral functions of the nth degree are equal to one another for more than n values of x, then they will be equal for all values of x, and the coefficient of any power of x in one function will be equal to the coefficient of the same power of x in the other function.**

Consequently when any two expressions with a limited number of terms are equal to one another for all values of the letters involved, the above condition must be satisfied, for the highest power of any letter must be less than the number of values; hence in such a case we may equate the coefficients of the different powers of any letter.

61. *To prove that a rational integral function of* x *can be resolved into only one set of linear factors in* x.

If possible let the function

$p_0x^n + p_1x^{n-1} + \ldots\ldots + p_{n-1}x + p_0$ be equal to

$p_0'(x - a)^r(x - b)^s(x - c)^t \ldots\ldots$ A

where $r + s + t + \ldots\ldots = n$ and also equal to

$p_0(x - \alpha)^k(x - \beta)^l(x - \gamma)^m \ldots\ldots$ B

where $k + l + m + \ldots\ldots = n$.

Put $x = a$ in A and B.

Then since A will vanish, B will also vanish, i.e. $p_0(a - \alpha)^k(a - \beta)^l(a - \gamma)^m \ldots\ldots = 0$.

$\therefore$ one at least of the quantities α, β, γ, etc., must $= a$.

Suppose $\alpha = a$ and divide both A and B by $(x - a)$ then each reduces to a function of the $(n-1)^{th}$ degree. Proceeding thus we prove that every factor of A occurs to as high a power in B, and $\therefore$ the expressions are identical.

62. A function is said to be symmetrical with regard to any set of operands when the value of the function is unaltered if any pair of the set of operands is interchanged.

Thus, $a^3 + 3a^2b + 3ab^2 + b^3$ is symmetrical in respect of a and b, and $b^2c + bc^2 + c^2a + ca^2 + a^2b + ab^2 + abc$ is symmetrical in respect of a, b and c.

The order of the operands in a function is said to be cyclic when each term can be derived from the succeeding one by what is termed a cyclic change.

Consider the expression $bc + ca + ab$.

If we change each letter into the one that follows it, i.e. b into c, c into a and a into b, we get $ca + ab + bc$. By this cyclic change the second term ca is derived from the first term bc, the third term ab is derived from the second term ca.

Expressions which are unaltered by a cyclic change are called **cyclically symmetrical.**

Examples of such expressions are,

$(b - c)(c - a)(a - b)$, $y^2z + z^2x + x^2y$,

$3x^2(y + z) + 3y^2(z + x) + 3z^2(x + y)$.

Clearly the products and quotients of symmetrical functions are themselves also symmetrical.

EXAMPLES:—

(1) Find the factors of $a^2(b - c) + b^2(c - a) + c^2(a - b) \equiv \mathrm{A}$.

If we put $b = c$, then A vanishes.

$\therefore$ $b - c$ is a factor of A.

Similarly we can see that $(c - a)$ and $(a - b)$ are factors.

$\because$ A is a function of the 3rd degree, $\therefore$ it can only have 3 linear factors.

$\therefore$ $\mathrm{A} = \mathrm{K}(b - c)(c - a)(a - b)$,

where K is some numerical factor (a constant) which is the same for all values of a, b and c.

Now we can equate the coefficients of any power of a, b or c in A with the coefficient of the same power in $\mathrm{K}(b - c)(c - a)(a - b)$, and this will give us the value of K.

Let us equate the coefficients of a^2

then $(b - c) = -\mathrm{K}(b - c)$

$\therefore$ $\mathrm{K} = -1$.

Hence $a^2(b - c) + b^2(c - a) + c^2(a - b)$

$= -1(b - c)(c - a)(a - b)$.

(2) Find the factors of $a(b - c)^3 + b(c - a)^3 + c(a - b)^3 \equiv \mathrm{A}$.

Here again we can see that $(b - c)$, $(c - a)$, $(a - b)$ are factors.

But A is symmetrical and of the fourth degree, $\therefore$ there must be another factor of the first degree which is also symmetrical, and this must be $a + b + c$.

$\therefore$ $\mathrm{A} = \mathrm{K}(b - c)(c - a)(a - b)(a + b + c)$.

Equating the coefficient of a^3 in A with that of a^3 in the last expression, we have

$-b + c = \mathrm{K}(b - c)$

$\therefore$ $\mathrm{K} = -1$

$\therefore$ $\mathrm{A} = -(b - c)(c - a)(a - b)(a + b + c)$.

(3) Find the factors of $(x + y + z)^5 - x^5 - y^5 - z^5 \equiv \mathrm{A}$.

If we put $y = -z$ in A, then A vanishes.

$\therefore$ $(y + z)$ is a factor of A. Similarly $(z + x)$ and $(x + y)$ are factors of A.

But A is symmetrical and of the 5th degree,

$\therefore$ there must be another symmetrical factor of the 2nd degree, and it will have the form $K(x^2 + y^2 + z^2) + L(yz + zx + xy)$.

$\therefore A = (y + z)(z + x)(x + y)\{Kx^2 + Ky^2 + Kz^2 + Lyz + Lzx + Lxy\}$.

Equating the coefficients of x^4 in A and the last expression, we have

$$5(y + z) = K(y + z) \quad \therefore K = 5.$$

Equating the coefficients of x^3, we have

$$10(y + z)^2 = K(y + z)^2 + L(y + z)^2$$
$$= (5 + L)(y + z)^2$$
$$\therefore L = 5$$

$\therefore A = 5(y + z)(z + x)(x + y)(x^2 + y^2 + z^2 + yz + zx + xy)$.

Exercise 10

(1) Divide $x^6 + x^2 + 1$ by $x^3 + 2x^2 + \frac{3}{2}x + 6$.

(2) Divide $\{(x - a)^{16} + (x - a)^8 + 1\}$ by $\{(x - a)^8 + (x - a)^4 + 1\}$.

(3) Determine p and q so that $x^4 + 5x^3 + 6x^2 + px + q$ may be exactly divisible by $x^2 - x + 1$.

(4) Find the remainders for

$$\frac{x^4 - 3yx^3 + 5y^2x^2 - 3y^3x + y^4}{x + 2y}$$

taking first x and then y as variable.

Factorise the following—

(5) $(a - b)^3 + (b - c)^3 + (c - a)^3$.

(6) $y^3z^3(y - z) + z^3x^3(z - x) + x^3y^3(x - y)$.

(7) $(y + z)(z + x)(x + y) + xyz$.

(8) $(a + b + c)^4 - (b + c)^4 - (c + a)^4 - (a + b)^4 + a^4 + b^4 + c^4$.

(9) Show that $a^3(b + c - a)^2 + b^3(c + a - b)^2 + c^3(a + b - c)^2 + abc(a^2 + b^2 + c^2) + (a^2 + b^2 + c^2 - bc - ca - ab)(b + c - a)(c + a - b)(a + b - c) = 2abc(bc + ca + ab)$.

(10) Show that $(y^2 - z^2)(1 + xy)(1 + xz) + (z^2 - x^2)(1 + yz)(1 + yx) + (x^2 - y^2)(1 + zx)(1 + zy) = (y - z)(z - x)(x - y)(xyz + x + y + z)$.

Key to Exercise 8

(1) $(3 - a)(3 + a)$. (2) $(6x - 5b)(6x + 5b)$. (3) $(ab^2c^3 - x^8)(ab^2c^3 + x^8)$. (4) $(x - 2b + 3c)(x + 2b - 3c)$. (5) $(x - 14y + 2z)x$. (6) $(a + 3b)(a^2 - 3ab + 9b^2)$. (7) $(x - 4yz)(x^2 - 2x^2yz + 4y^2z^2)$. (8) $-24x(2x^2 - 1)$. (9) $ab(a - 4ab + 3b^2)$. (10) $(a + b - 5c)(a + b - 2c)$. (11) $(y + 11)(y - 10)$. (12) $(x - 15)(x + 6)$. (13) $(4a^2 + 9b^2)(2a + 3b)(2a - 3b)$. (14) $(x - y)(x + y)(x^2 + xy + y^2)(x^2 - xy + y^2)$. (15) $(x^2 + xy + y^2 - a^2 - ab - b^2)(-x^2 + xy - y^2 + a^2 - ab + b^2)$.

Key to Exercise 9

(1) $(a + b - c - d)(a - b + c - d)$. (2) $(2x + y + 1)^2$. (3) $(x - p - q)(x - p + q)$. (4) $(x + a)(x + b)$. (5) $(x - \sqrt[4]{a})\{x^2 + \sqrt[4]{a}x + (\sqrt[4]{a})^2\}(x + \sqrt[3]{b})\{x^2 - \sqrt[3]{b}x + (\sqrt[3]{b})^2\}$. (6) $(x^4 + y^4)(x^2 + y^2)(x + y)(x - y)$. (7) $(1 - x)^2(1 + x + x^2)^2$. (8) $(3x - 1)^3$. (9) $(x^2 - 3x + 9)(x^2 + 3x + 9)$. (10) $(a + b)(a - b)(a^2 + ab + b^2)$. (11) $(x^4 - x^2 - 1)(x^4 + x^2 - 1)$. (12) $(x - y + z)(x + y - 3z)$. (13) $(x^2 + 4xy + y^2)(x^2 - 4xy + y^2)$. (14) $(x^2 + a)(x + b)$. (15) $(x + 8)(2x + 15)(2x^2 + 35x + 120)$. (16) $(x^2 + x + 1)(x + p - 1)$. (17) $(x - 1)^2(x^2 + 2x + 3)$. (18) $(x^2 - yz)(y^2 - zx)(z^2 - xy)$. (19) $-(x - 1)(2x - 3)$. (20) $(x - 3)(2x + 3)(x^2 + 3x + 3)$. (21) $(1 + ax)(1 + x)(1 - x)$. (22) $(2x + a)(2x - b)(2x + c)$.

M. A. L.

GEOMETRY.—VII

Proposition 31. Theorem

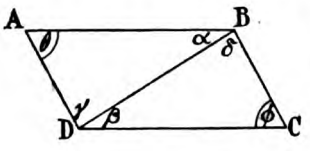
In any parallelogram, (1) *opposite angles are equal,* (2) *opposite sides are equal,* (3) *the diagonals bisect the parallelogram.*

Let A B C D be a $\square$. Let B D be a diag.

It is required to prove that (1) $\theta = \varphi$.

(2) A B = C D, A D = C B

(3) $\triangle$ A B D = $\triangle$ C D B



Proof:

B D cuts the $\parallel$ lines A B, C D

$\therefore \alpha$ = alt. $\angle$ β

B D cuts the $\parallel$ lines A D, C B

$\therefore \gamma$ = alt. $\angle$ δ (Prop. 26).

In $\triangle$s A B D, C D B

B D is common

$\alpha = \beta$

$\gamma = \delta$

$\therefore$ $\triangle$ A B D $\equiv$ $\triangle$ C D B (Prop. 9)

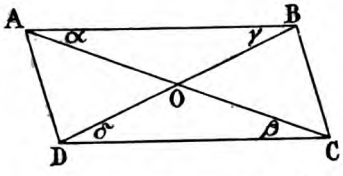
i.e. B D bisects the $\square$.

Also A B = C D, and A D = C B, and $\theta = \varphi$.

Similarly we may show that the diag. A C bisects the $\square$ and that $\angle$ A B C = $\angle$ C D A

Corollary I.—The diagonals of a parallelogram bisect each other.

Let the diags. A C, B D of the $\square$ A B C D cut each other at O.



In $\triangle$s A O B, C O D

α = alt. $\angle$ β

γ = alt. $\angle$ δ (Prop. 26)

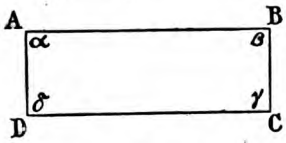
A B = C D (Prop. 31)

$\therefore$ $\triangle$ A O B $\equiv$ $\triangle$ C O D (Prop. 9)

$\therefore$ A O = C O and B O = D O

i.e. the diags. bisect each other.

Corollary II.—All the angles of a rectangle are right angles.



Let A B C D be a rect. having α a rt. $\angle$.

γ = opp. $\angle$ α (Prop. 31)

$\therefore \gamma$ = 1 rt. $\angle$

$\because$ B C is $\parallel$ to A D

$\therefore \alpha + \beta$ = 2 rt. $\angle$s (Prop. 26) but α = 1 rt. $\angle$

$\therefore \beta$ = 1 rt. $\angle$.

Similarly δ = 1 rt. $\angle$

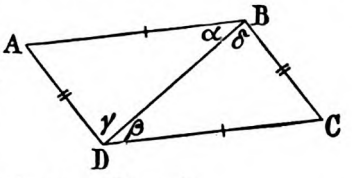
i.e. all the $\angle$s of the rectangle are rt. $\angle$s.

Proposition 32. Theorem

If the opposite sides of a quadrilateral be equal, the quadrilateral is a parallelogram.

Let A B C D be a quadrilateral having A B = C D, and A D = B C.

It is required to prove that A B C D is a ▱.



Proof.—Join B D.

In △s A B D, C D B

A B = C D
A D = C B
(hypothesis)
B D is common

∴ △ A B D ≡ △ C D B (Prop. 8)

∴ α = β and γ = δ

but α and β are alt. ∠s ∴ A B is ‖ to C D

and γ and δ are alt. ∠s ∴ A D is ‖ to B C (Prop. 23)

i.e. A B C D is a ▱.

Corollary.—A square is a rectangle having four equal sides,

∵ its opp. sides are equal it is a ▱

and ∵ it is a ▱ with one ∠ a rt. ∠ ∴ it is a rect.

Note.—Where no confusion can arise, a quadrilateral or a ▱ is often designated by the letters at opp. corners.

Thus the above figure may be described as the quadrilateral A C.

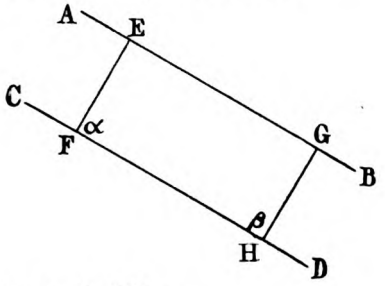
Definitions.—The *base* of a parallelogram is its lowest side, but since we may turn the figure round we may treat any side as the base. Similarly we may treat any side of a triangle as its base.

The *altitude* of a parallelogram is the perpendicular distance between the base and the opposite side.

The *altitude* of a triangle is the perpendicular distance from its vertex to its base.

Important Additional Theorem. B

The perpendicular distance between two parallel straight lines is everywhere the same.



Let A B, C D be ‖ lines.

In A B take any two pts. E and G.

Draw E F, G H ⊥ to C D.

It is required to prove that E F = G H.

Proof. α = 1 rt. ∠, β = 1 rt. ∠, ∴ α + β = 2 rt. ∠s

but these are int. ∠s ∴ E F is ‖ to G H (Prop. 25),

i.e. E G H F is a ▱

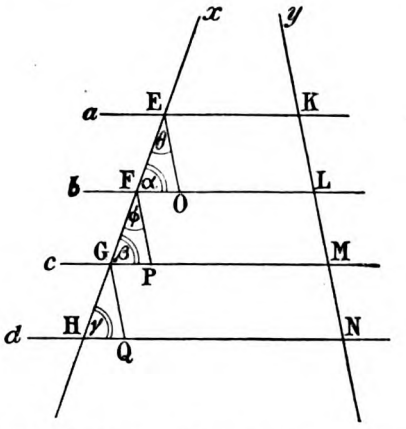
∴ E F = G H (Prop. 31).

Important Additional Theorem. C

If several parallel straight lines make equal intercepts on one transverse line, they make equal intercepts on all transverse lines.

Let the ‖ lines *a*, *b*, *c*, *d* make equal intercepts E F, F G, G H on a transverse line *x*, and let *y* be any other transverse line on which they make intercepts K L, L M, M N.

It is required to prove that K L = L M = M N.



Proof.—Draw E O, F P, G Q ‖ to *y* (Prop. 29)

E O is ‖ to *y* and F P is ‖ to *y*

∴ E O is ‖ to F P (Prop. 28)

∴ θ = corresponding ∠ φ (Prop. 26)

b is ‖ to *c* ∴ α = corresponding ∠ β (Prop. 26).

In △s E F O, F G P

θ = φ
α = β
E F = F G (hypothesis)

∴ △ E F O ≡ △ F G P (Prop. 9)

∴ E O = F P

Now E K L O is a ▱ ∴ E O = K L

and F L M P is a ▱ ∴ F P = L M } (Prop. 31

∴ K L = L M.

Similarly we may show that L M = M N.

Proposition 33. Theorem

Parallelograms on the same base and between the same parallels are equal in area.

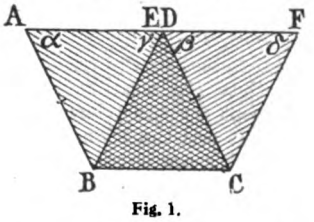


Fig. 1.

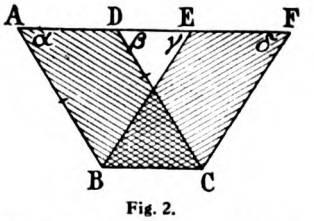


Fig. 2.

Let A B C D, E B C F be ▱s on the same base B C and between the same ‖s A F, B C. (Figs. 1, 2, 3.)

It is required to prove that A B C D, E B C F are equal in area.

Proof.—In △s A B E, D C F

α = corresponding ∠ β } (Prop. 26).
γ = corresponding ∠ δ }

A B = D C (opp. sides of a ▱, Prop. 31).

∴ △ A B E ≡ △ D C F.

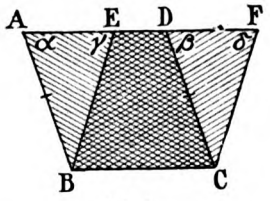


Fig. 3.

From whole fig. A F C B take away △ A B E, ▱ E B C F remains.

From whole fig. A F C B take away △ D C F, ▱ A B C D remains

but ∵ △ A B E = △ D C F, these remainders are equal.

∴ ▱ A B C D = ▱ E B C F.

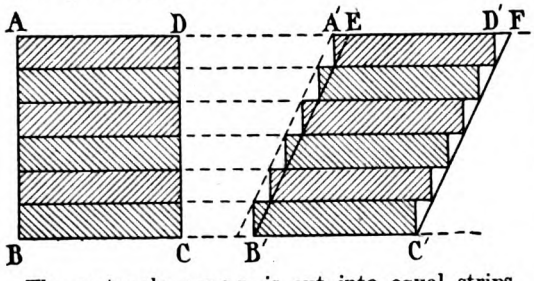
Corollary.—*The area of a parallelogram is the product of its base multiplied by its altitude.*

∵ a rect. is a ▱ ∴ a rect. = in area any ▱ on the same base and between the same ‖s.

But the area of a rect. = product of its base multiplied by its altitude.

∴ area of a ▱ = base × altitude.

The student may derive advantage from considering the figures below.



The rectangle A B C D is cut into equal strips. The lowest is placed at B′ C′, and each of the others pushed slightly to the right, so that each overhangs the next lowest to the same extent.

The figure thus produced coincides with the □ E B′ C′ F except for the triangular pieces projecting on the left and the triangular indentations on the right, which are equal to one another in area and ∴ counterbalance one another.

Proposition 34. Theorem

Parallelograms on equal bases and between the same parallels are equal in area.

Let A B C D, E F G H be ▱s on equal bases B C, F G and between the same ‖s B G, A H.

It is required to prove that ▱ A B C D = ▱ E F G H in area.

Proof.—Join E B, H C.

E H = F G (opp. sides of a ▱, Prop. 31)

but F G = B C (hypothesis)

∴ E H = B C

∵ E H and B C are equal and ‖

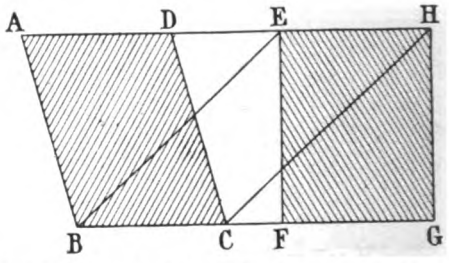
∴ E B and H C are equal and ‖ (Prop. 30)

i.e. E B C H is a ▱.

▱ A B C D = E B C H (on same base B C and between same ‖s [Prop. 33]).

▱ E F G H = ▱ E B C H (on same base E H and between same ‖s [Prop. 33]).

∴ ▱ A B C D = ▱ E F G H.



Corollary 1.—*Parallelograms on equal bases and of the same altitude are equal in area.*

Corollary 2.—*Converse of Prop. 34. Parallelograms of equal area on equal bases which are in the same straight line are between the same parallels.*

Converse of Corollary.—Parallelograms of equal area on equal bases are of the same altitude.

Exercise 9

1. Prove that if the diagonals of a parallelogram are equal, it must be a rectangle.

2. If straight lines are drawn bisecting two adjacent angles of a parallelogram, prove that they cut at right angles.

3. The diagonals of a rhombus bisect one another at right angles.

4. Through a given point D within an angle B A C draw a straight line terminated at either end by the lines B A, C A at points E and F, such that E D = D F.

5. Every straight line drawn through the point of intersection of the diagonals of a parallelogram divides the parallelogram into two equal parts.

6. Through the angular points A, B, C of a triangle A B C, straight lines are drawn parallel to B C, C A, and A B respectively. Prove that the triangle thus formed is four times as large as the triangle A B C.

Hints on Exercise 7

15. If A B be the str. line, descr. a ⊙ with centre A and radius A B, and another with centre B and same radius. Join their pt. of intersection with A and B.

16. With centre B and radius = twice B C descr. a ⊙, and with centre C and same radius descr. another ⊙ with same radius, cutting first ⊙ at A.

17. Join A B. With centre A and any convenient radius descr. a ⊙. With centre B and same radius descr. another ⊙. From their pt. of intersection draw a line ⊥ to A B. Any pt. on this line is equidist. from A and B.

18. Bisect ∠s at B and C. Let bisectors meet at O. Then O is required pt.

19. Produce A B to D, making B D = A C. With centre A and radius = half A D descr. a ⊙ cutting B C at B.

20. With centre C and radius = 1 in. descr. a ⊙. Join A B and bisect A B at D. From D draw a line ⊥ to A B. The required pt. is the pt. or points where this ⊥ cuts the ⊙. If the ⊥ does not cut the ⊙, the problem is insoluble. M. A. L.

Continued from page 442.

ART AND MUSIC:

Contributors:—THE THEORY OF ART (Hon. John Collier; J. G. B. Lynch). DRAWING AND PAINTING (J. G. B. Lynch). THE THEORY OF MUSIC (R. R. Terry, Mus.Doc., F.R.C.O.; Hubert Grant).

THE ART OF PHIL MAY

IT is a perpetual joy to linger over old volumes of *Punch* for a variety of reasons. But if you scrutinise those which bear the date of the middle and later 'nineties you may feast upon what may still be regarded as the most compelling and vigorous black and white work of an avowedly "comic" sort that ever shook the world's sides with laughter.

For it was through the medium of *Punch* that Phil May chiefly became known to the public. In the first place his work is remarkable for the extreme economy of means. He never drew a line or part of a line that was not full of meaning or that was in any way unessential. Of course, I am now talking of his irreverently called "lightning sketches." Occasionally he did much more orthodox work, even for *Punch*, and here and there may be seen pencil drawings and sketches in colour which are by no means typical though quite admirable in their own way.

It is, however, the sketches and caricatures which consist of so remarkably few lines by which Phil May is best known. Like many brilliant artists, his working life was a regrettably short one. He was the artist of low life in London. His types of amusingly degraded faces are almost classical. The adventures of his 'Arry and 'Arriet are splendid in their ruthless expression of vulgarity and appreciation of the absurd.

A STUDY BY PHIL MAY.

All great artists, of course, make enemies. And adverse critics of Phil May and his work attempted to show that his method was not so inspired as the result seemed to prove. They said that he first made a full pencil sketch of his subject, and that he then inked over the essential lines and rubbed out what remained. But this was libel. The certainty and determination of his work admit of no such expedient.

Amongst the types which helped to make his name—such was the extreme vivacity of their rendering at his hands—may be named particularly the costermonger and the Jew. The Progress of Ikey from Petticoat Lane to Park Lane is sublime in its splendid impertinence.

Phil May at one period of his career found himself irresistibly attracted—as is the case with most artists at one time or another—by Holland. A study in chalk is reproduced here, showing a Dutch child in contemplation of the skies. It is but a study—not specially remarkable. But the eye of the girl alone immediately gives the artist's name to the most cursory student. That eye, and perhaps the poise of the head as well, cannot be mistaken. They are redolent of Phil May.

It is for his personal qualities no less than his work that Phil May is remembered with affection and regret in the minds of his contemporaries. The atmosphere of Bohemian joviality attracted him, and he made himself

loved wherever in London genial spirits of the brush and pen met in convivial ease.

Perhaps one of his most masterly caricatures is that of Sir Henry Irving which hangs upon the wall of one of the rooms in the Savoy Club. This is just a big head done in black and red chalk, the features delineated in fine, free, bold, black lines, and the scarlet cap making a gorgeous decorative effect and emphasising the pallor of the face.

Like many artists, Phil May loved to caricature himself, which he did with the utmost brutality. In many of his *Punch* groups you may recognise him, and numerous separate portraits are to be found in collections of his work. You may always know him by the long nose, humorous full mouth, twinkling black eyes (they really do twinkle even in the slightest sketch), and the deep straight black fringe which he brushed smoothly over his forehead. Added to this there is usually a long cigar.

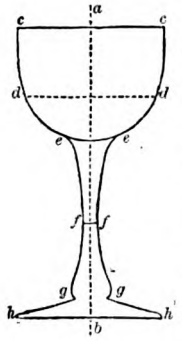


Fig. 23.

Indeed, quite a gallery of self portraiture might be made of Phil May's caricatures of Phil May. His personal characteristics might almost be read from his work —humour, generosity, love of children and animals. No child raised a piteous face to him in vain, nor footsore weary dog a deprecating paw.

The reader will find on the next page a characteristic sketch by Phil May of himself, in which he shows himself joyfully at work in the studio where he won so many friends and admirers.

J. G. B. L.

DRAWING.—VI

You will find it useful, before going on with lessons in Perspective and other technical branches of drawing, to pay attention to the various pitfalls and mistakes

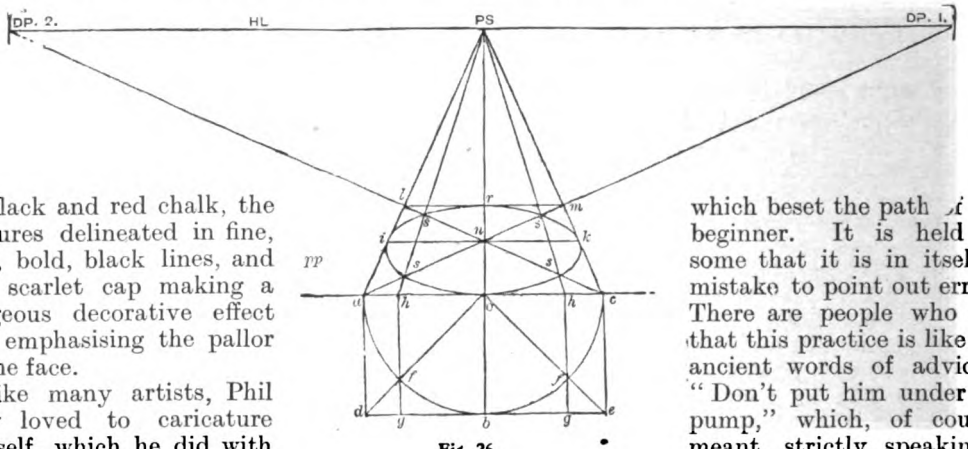


Fig. 26.

which beset the path of the beginner. It is held by some that it is in itself a mistake to point out errors. There are people who say that this practice is like the ancient words of advice—"Don't put him under the pump," which, of course, meant, strictly speaking—"You fools, why haven't you thought of putting him under the pump?" That is to say, applied to the art of drawing, if you point out a possible or a likely mistake, someone, who had not previously thought of it, will at once make it. The answer to this argument is that in drawing, the beginner generally makes every possible mistake at one time or another; and it is much better that he should. Because by mistakes you learn, provided always that you also correct them and know them to be mistakes, and do not repeat them. It is, however, just as well to be on your guard against several pitfalls; for if you know of them beforehand you will guide your steps accordingly, and so avoid them altogether, and in this way much valuable time will be saved. The dreadful thing about all mistakes, whether in drawing or other branches of

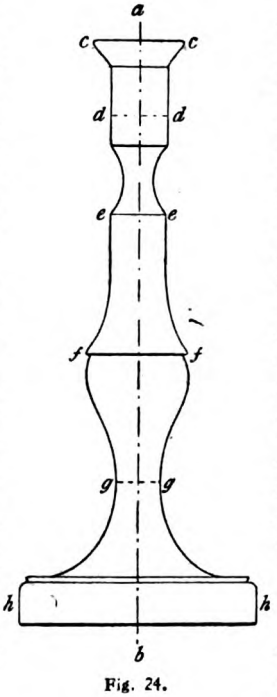


Fig. 24.

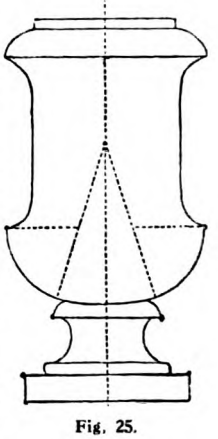


Fig. 25.

art, or in any other relation of life whatsoever, is that they so o ten pass unseen, unrecognised rather, by the people who commit them. But if they are seen or pointed out by some master or friend, and if, as sometimes does happen, the student recognises for himself, then they are really valuable. You will by mistakes get to learn more about art than if (probably by good luck) you did not make them. If you make a mistake, it can be pointed out to you why it is a mistake ; and so you learn something fresh about your art. So mistakes in their way come to be as useful as a piece of drawing correctly done.

It is in the arrangement of a subject that a student is often prone to go wrong at the outset of things. In the first place, if you make a mistake when you first draw your group of objects, do not rub out the wrong lines entirely, but only faint them. Then they will serve as a guide when you come to draw the finished outline. If you rub out the erratic lines completely, you will be surprised how often you will return to them and make the same mistake again. Another bad mistake which may arise from the first error being entirely obliterated is in the extreme opposite direction. If you draw a curve, which we will call x, as part of the outline of a jug, and you see that it is too far to the left, making your jug too fat in shape, you rub it out so that you cannot see where it was, and draw another line y. Then you see that y is wrong, and after a moment you realise that you have come from one extreme to the other and have brought it too far to the right, thus making your jug too thin and narrow. If you had left in the original line x, just faintly visible, you would have been better able to see the true place for the right line z. After all, you can always finish the rubbing out of your line later on, when you come to do the finished outline. Try to remember always the enormous importance of arranging your subject before getting seriously to work, and never on any account to draw a line without carefully marking its position first, perhaps in as many as half a dozen or more places. After a time you will learn by this means to draw a perfectly true line without help. But even when you can do that, the position—that is to say, the two extreme points between which the line runs—should be marked first.

PHIL MAY.
A Drawing of Himself by Himself.

It is now time to consider objects the two sides of which are the same—round things, pots, tumblers, candlesticks, bottles—the list is innumerable. There are various aspects in which these should be regarded, of course; and in time you must learn to depict every aspect. But the simplest is naturally to be taken first, and that will be the plain profile — the simplest outline of the object in question as shown to the eye directly, on the horizontal. Then there can be no question of perspective to trouble you, and all you have to consider will be the straightforward outline.

For this exercise first take Fig. 24. This is a plain candlestick, such as might be made of brass or china or gunmetal. First make a perpendicular line *a b* which shall divide the object into two equal halves. All uniform objects like this should be so drawn, because with a straight line in the middle you have a sure guide. You know that where there is a "waist," the lines narrow in towards the middle line and that each reaches its narrowest or widest at exactly the same distance from the middle. The important points on the outline of Fig. 24 are *c d e f g h*. These are repeated on either side. As the reader can see for himself, never was an instance where the accurate marking of distances was so important. In fact, that is really all that need be done. Mark your positions well, and with a steady hand you can hardly fail to make a correct drawing.

Fig. 25, which represents a flower vase, can be treated in precisely the same way. Take any such object and mark the important points for yourself

with letters as for Figs. 23, 24. This drawing of objects in profile is simple and easy enough. But now we come to something rather less easy, and therefore more important, and that is round, uniform objects drawn in perspective. For this you have to make use of geometrical perspective.

Take Fig. 26 as the first exercise. For this parallel rulers and compasses are necessary. First of all make your horizontal line over the picture plane and parallel to it. Mark the P.S., and from it draw a perpendicular line P.S. *o b*. With centre *o* and radius *o b* draw the semicircle *a f b f c*: let that semicircle be contained in a rectangle which you draw next, *a d e c*. Next draw *o d* and *o e*, then draw *h g* twice through the two points *f*. From *a h o h* and *c* draw five lines to the P.S. On either side of the P.S. on the line of sight mark two points, D.P. 1 and D.P. 2. D.P. stands for Distance Points, and show the distance of the eye from the picture plane. Draw diagonal lines from *c* and *a* to the D.P.s. These lines are *a m* and *c l*. Join *l m*. Then *l m c a* will be a square in perspective. Having arrived at that you can draw the circle in perspective too. Mark he point where the diagonals cut each other as *n*. This will be the centre of the square, on the same principle as the end of the house in Fig. 22. Now draw the line *i k* through *n* and parallel to *a c*. You will see now that the lines from the two *h's* cut the diagonal lines at four places *s s s s*. Now you can draw a perspective circle through the four *s's* and through the points *r i o k*. *This circle in perspective should be drawn by hand without any aid.*

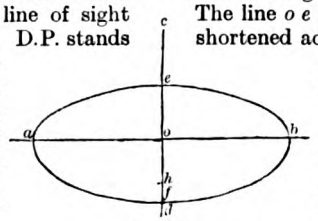


Fig. 27.

The exercise above is by no means an easy one. It requires the very greatest care and patience. Be particularly careful to letter the points plainly, so that you cannot confuse one with another. If repeated until you are perfect at it, the exercise will repay all the care and pains you have bestowed on it.

Having well practised this study in geometrical perspective you can go on to the more advanced method without the use of geometry. Draw a horizontal line *a b* which is the necessary width of the required circle, mark its middle *o*. Draw a perpendicular line through *o*, and call it *c d*, between *c* and *o* mark *e*. Then mark *o h* of the same length as *x e*. Divide *o h* into three equal lengths, and add one of these lengths from *h* to *f*. Then *a e b f* will be the points through which you will draw your perspective circle. You may not get a result which is mathematically precise, but it will be near enough for all purposes of ordinary drawing.

The line *o e* (*see* Fig. 27) must be lengthened or shortened according to the view you have of the object, which in this case may be considered the top of a tumbler.

Fig 28 is important, though, after the exercises that you have already studied, it should present little difficulty. Draw H L and fix the P.S. Place *a* where the perpendicular line of the wall comes on the right, and then *d* and *e* all on the same line. Draw perpendicular lines through *a* and *e*, to form the rectangle *f m b k*. Find the middle of this by the point of intersection of the two diagonal lines *f k* and *m b*, at *i*. The line *i h* is then the middle of the arch.

You should learn now the geometrical rule for bisecting a straight line. (*See* p. 374, Prop. 20.) Let *a b* be your straight line. With centre *a* and radius *a b* make with your compasses an arc. Repeat the process with centre *b* and radius *b a*. Then repeat on the other side of your original line. This will give the points *x* and *y*. The straight line joining *x y* will bisect *a b*.

J. G. B. L.

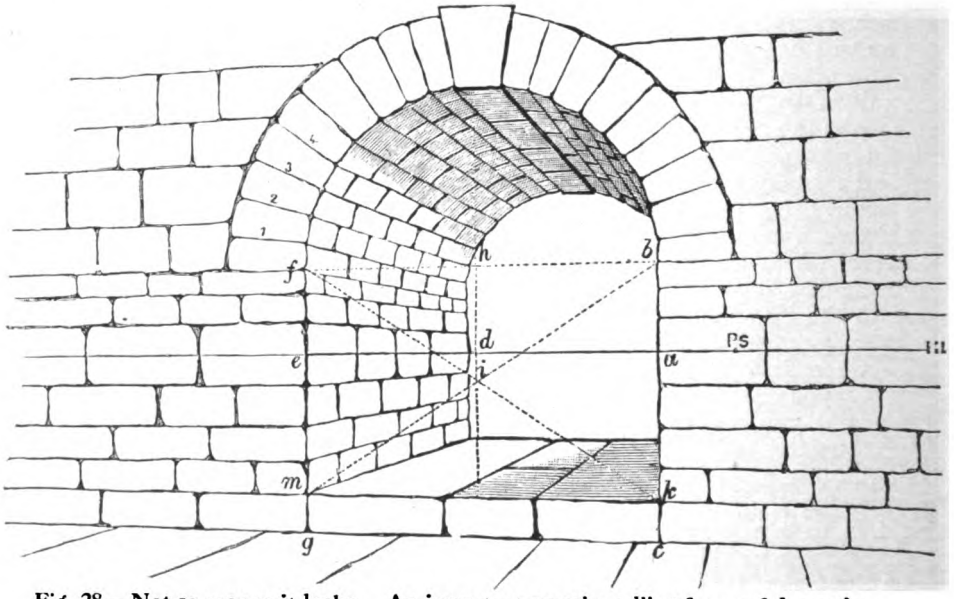


Fig. 28.—Not so easy as it looks. An important exercise calling for careful practice.

Continued from page 448.

BUSINESS AND COMMERCE:

***Contributors*:—BOOK-KEEPING (Frederick Heelis, F.C.I.S.). SHORTHAND (by arrangement with Pitman's Schools). COMMERCIAL TRAINING (Arthur Brooke). CHOOSING A CAREER (A. C. Marshall).**

COMMERCIAL TRAINING.—VIII

It may be pointed out that business letters frequently embody the tabulation of quotations, and when this type of work has to be done the scale must be used with the utmost care to afford both accuracy and neatness. Here is an example, showing exactly how to type such tabulation; the single spacing being employed, the line beginning at 15 by the scale.

Dear Sirs,

re Garden Rollers.

We have pleasure in handing you the following quotations for double-cylindered rollers of the latest type:—

14 x 14	.....	1	cwt.	2	qr.	14	lb.	£1	: 9 : 0.
16 x 16	.....	2	....	0	...	0	.....	1	: 12 : 9.
18 x 18	.....	2	....	2	...	0	.....	1	: 19 : 10.
20 x 20	.....	3	....	1	...	14	.....	2	: 6 : 0.

These are carriage paid prices for net cash with order.

Awaiting the favour of your reply,

Yours faithfully,

It will be seen from this example the importance of neat tabulation, and the actual spacing must naturally be planned with the first line. Thus, in the money columns, though in the first line we only write £1 : 9 : 0., the colon after the £1 must be followed by *two* spaces, and the colon after 9 by *two* spaces, because in the lower items we have to insert 12, 19 and 10, which are double numerals. The use of the full stop will be appreciated from this example, and also the importance of the hint already given—to press this particular key but lightly when typing.

The fact that under the loose-leaf system even ledgers and account books of all kinds are kept with the typewriter proves to what extent a knowledge of neat tabulating is necessary. For this more advanced purpose the ordinary typewriter, which writes a line eight inches long, gives way to a machine with a carriage double that width, and such machines are equipped with movable stops, by means of which the carriage automatically draws up at the particular starting point as one uses the release lever. Such machines are also equipped with keys or marginal releases, by means of which the carriage may be made to pass a stop, to leap over it as it were, according to the requirements of the tabulating in progress.

If anything, it is easier to correct a slight

mistake in a typewritten letter than in one written by hand. All that you need is a piece of typewriter eraser and a sheet of paper in which a hole about half an inch by one inch has been cut. The paper is to act as a shield to the typing that is correct, and specially made shields are to be bought for the purpose, at shops where typewriter sundries are sold. To make the correction, lay the shield over the misspelt word, gently rub it out with the eraser, and then go back with the machine and fill it in, finding the exact place by means of the scale so often referred to in these lessons.

But before we actually finish with the typing of letters there are one or two minor matters to be explained. Many firms, for instance, have at the top of their letter paper small circles or ovals in which, in tiny letters, appear the words: "In Your Reply Please Refer To: ." A blank follows, and it will be the typist's duty to insert the directions, whatever they may be according to the rule of the firm.

Some firms might put a numeral referring to the number of a correspondence file; others "Country," meaning "Country Department"; others "C.H.," meaning Counting House, and so on.

Often it is the rule of a firm that every letter shall bear the initials of the writer and of the typist, so that if Mr. Basil Fry dictated a letter to Miss Phyllis Morgan to send to Messrs. Fry, Dawson & Co., Ltd., the top of the letter under the printed heading would be something like this:

B. F. / P. M. March 22nd, 1919.

Messrs. Fry, Dawson & Co., Ltd.

When documents or invoices are to be enclosed with a letter, or a postal order or a stamped envelope, there should be neatly typed in at the bottom left-hand corner of the letter: 1 Enclo: or 3 Enclos:, as the case may be.

You will notice how and where commas are employed, and also that the name of the actual city is written in capitals. Envelopes of business size are easily inserted in most typewriters and no backing sheet is necessary with them; most machines will also take thin post cards quite simply. In the case of foolscap envelopes (9 × 4) and other envelopes which are long and narrow, they are usually addressed on the machine lengthways.

At the same time there are many firms that adhere to the older rule to address foolscap envelopes sideways, in which case a 10-space allowance is usually made for the start of each new line.

One of the most simple ways of duplicating with a typewriter lies in the use of carbon sheets; in fact there are some firms that preserve and file carbon copies of all letters dispatched instead of resorting to the press-copy book. Typewriting carbon sheets have one plain side and the carbonised side, and cost about 1½d. per sheet in the quarto size. Varying according to the make of typewriter, from two to ten duplicate copies may be made at one typing if thin duplicating paper be employed. The carbonned side of the sheet comes next to the paper upon which a copy is to be made. When attempting to make a considerable number of copies, one must naturally strike the keys a little harder than usual and if possible a trifle more evenly.

The majority of duplicating machines used in modern offices are also adaptable to typewriters, a specially prepared waxed sheet being used for making the original text or stencil. Obviously, when typing such a document, only slow, patient and most careful typing will yield satisfactory results.

A. B.

Messrs. Fry, Dawson & Co., Ltd.
(Country Department),
271 Cranford Lane,
Westminster, LONDON, S.W.

Example of how an ordinary business-size envelope should be addressed.

CHOOSING A CAREER.—VIII

Emigration (*continued from p.* 446).—HAVING dealt with the Union of South Africa generally, we will now examine the separate States from the point of view of the intending emigrant.

Th Cape. There is a Government Agricultural School at Elsenburg where the farming methods of the country are taught in a thoroughly practical manner, the fees amounting to between £35 and £40 a year for tuition, board and lodging. Arable farms, of not less than 200 acres with buildings, may be purchased at from 30s. to £3 an acre, and here, much as occurs in Australia, the "shares" system of farming prevails, landlord and tenant dividing the produce on agreed terms. Land for stock-keeping costs from 15s. to £1 an acre.

Wheat, barley and oats are very largely grown; maize, tobacco and grape-vines also flourish in different parts; all kinds of fruit are grown, and experts prognosticate a great future for this class of farming, for both fresh and dried fruits are sent to the British markets in ever-increasing quantities.

Natal. This province may be divided into coast lands, midland districts and upper districts. In the coast lands the climate is sub-tropical, and tea, maize, bananas, pineapples and similar produce are grown. The midland districts are suitable for the cultivation of all European cereals and root crops, and the land is ideal for stock raising. A great industry is springing up here with wattle-bark, which is shipped to England for tanning purposes.

In the upper districts, cattle rearing and sheep farming form the main industries, though vast quantities of cereals are grown. A farmer would require considerable capital to start operations, however, and even then he should have worked in the province for some time to acquire a complete knowledge of local conditions.

Transvaal. Agriculture in this province is in a flourishing and improving condition, and there are considerable openings for farmers, though it is essential that they should first have obtained some personal experience of the methods of South African farming. The average mixed farms are of a thousand acres at least, and a capital of not much less than £1,000 is necessary.

There are many orange orchards in this province, and tobacco is largely grown, whilst experiments are being made in the growing of cotton. Farmers who would settle in the Transvaal must remember that there are conditions to be reckoned with more trying than those of the Home Country—lack of water, fierce hailstorms, attacks of locusts and late frosts, to mention a few.

Orange Free State. In this province the principal crops are wheat, oats and mealies, and the greatest industry is sheep farming. Cattle do well, and the country is particularly adapted for horse breeding. Poultry farming should prove to be a profitable undertaking, but it is usually far more satisfactory for all farmers here to rely upon native rather than upon white labour.

In this province, again, £1,000 is spoken of as a comparatively small capital upon which to take a farm, and then the venture should be begun only after obtaining first-hand experience of the methods of the province.

For those who would take up gold mining in the Transvaal there is a training school at the Wolhuter Gold Mine, Johannesburg. Applicants must be from 17 to 25 years of age, and, though they receive a daily cash allowance, monthly deductions are made for board. In Natal, in the Dundee, Klip River and Newcastle districts there are vast coal fields, but the demand for white labour is not great.

Rhodesia. This is a vast country to the north of the Transvaal, divided into two sections, the southern with the towns of Salisbury and Bulawayo, and the northern with the town of Livingstone. That it is a country with great openings for the white settler there can be little doubt, for most of it is situated at high altitudes and offers a healthy and delightful climate, without undue extremes of heat and cold.

Many parts of Rhodesia are particularly adapted for cattle raising, for mixed farming, and for the growing of cereals and fruits, whilst oranges may be produced to perfection. Gold mining is naturally the staple industry of this great new country as yet, but the agricultural side is certain to develop more and more rapidly, particularly as the railways advance.

Land may be purchased for as little as 8s. an acre, and there are experimental farms where student settlers may be admitted. For full particulars of the latest conditions pertaining, and for advice, intending settlers should communicate with the *Secretary, the British South Africa Company, London Wall Buildings, London, E.C.*

For South Africa generally would-be emigrants should apply for information to the *High Commissioner for the Union of South Africa, 32 Victoria Street, London, S.W.*1.

A. C. M.

BOOK-KEEPING.—VI

We will now explain how items of interest are treated in book-keeping.

If goods are purchased on credit, the books of the buyer will show that he is indebted to the seller for them. In the same way, it is necessary to make an entry in the books when interest is charged. Unless an entry is made, the books cannot be said to reveal the true state of the trader's affairs.

Credit and Interest

It is clear that such a charge cannot be made through the Cash Book, as it does not represent either a receipt or payment for the time being; neither has the transaction anything to do with the purchase or sale of goods. The only book in which such a charge can properly appear prior to being posted to the Ledger is the Journal. The Personal Account of the Debtor is debited with the amount of interest due, and an account is opened for Interest, and this account is credited.

To take an example: Supposing that on account of a payment which is long overdue the sum of £2 10s. is charged by Thomas Brown to James Green by way of Interest. James Green's account will be debited, and an Interest Account opened in Brown's books will be credited. Green will ultimately be required to pay the amount, hence he is debited, and Interest Account is credited.

The Journal entry will be:—

			£	s.	d.	£	s.	d.
James Green	*Dr.*		2	10	–			
To Interest Account						2	10	–

The corresponding entry in Green's books will, of course, be:—

			£	s.	d.	£	s.	d.
Interest Account	*Dr.*		2	10	–			
To T. Brown						2	10	–

The owner of a business may consider it desirable to charge his business Interest on the Capital invested in it before arriving at the amount of his profits. This practice is frequently followed when two persons are in partnership, and especially where the Capital of the two persons is not equal. In such a case an Interest Account would be opened and debited with the amount agreed upon, the Capital Account being credited.

The value of the assets in a business is often reduced by reason of the wear and tear to which they are subjected, and it is only fair that the business should, year by year, bear a proportion of the cost of replacing or making good such depreciation in value.

If, for example, plant and machinery is represented in the books at the beginning of the year by the sum of £500, it is obvious that after a year's use the value will be reduced. Supposing it is found that the average decrease in value amounts to 5 per cent.; when the books are made up the Depreciation Account will be debited with £25, as it represents a distinct loss, the Plant and Machinery Account being credited so that the amount standing in the Account is reduced to £475.

The subject of depreciation is of great importance, and can only be touched upon at this stage; it will, however, be adequately and fully dealt with in a subsequent Lesson.

Bad Debts

He is a fortunate business man who does not have dealings with people who are unable to pay all they owe, and who have to be excused from paying all or part of their debts. There comes a time when a debt is recognised as being either totally bad—that is, altogether irrecoverable—or so doubtful as not to be worth keeping on the books as an asset. It then becomes necessary to write off the amount, or to make suitable provision for it in the accounts.

Supposing A. Triwell buys goods to the value of £150 from B. Trustwell, and that within one month he pays £100 on account of the debt. Shortly afterwards Mr. Triwell finds that he is unable to pay his debts in full. By careful calculation he knows he is only able to pay half the amount. He then pays to Mr. Trustwell £25, which is accepted

in full settlement of his indebtedness. Having been credited with this amount, his Ledger Account still shows a balance of £25 unpaid. It is clear that it will never be paid, and it becomes necessary to close the account and look upon the £25 as lost. This is done by means of a Journal entry as follows :—

			£	s.	d.	£	s.	d.
Bad Debts Account	*Dr.*		25	–	–			
To A. Triwell						25	–	–

The posting of these Journal entries will result in the closing of Mr. Triwell's account, and the transference of the loss to the Bad Debts Account.

Mr. Triwell may within a comparatively short time recover himself, and be so far successful as to be able and anxious to pay off his former debts in full, although under no legal obligation to do so.

He pays to Mr. Trustwell the sum of £25, which is duly recorded in Mr. Trustwell's Cash Book as follows :—

Dr. CASH				CONTRA			*Cr.*
	£	s.	d.				
To Bad Debts Recovered	25	–	–				

and this amount will be posted to a Ledger Account which will then appear as follows :—

Dr. BAD DEBTS RECOVERED				*Cr.*
	£	s.	d.	
By Cash	25	–	–	

The last Account will be closed by the amount recovered being transferred to the credit of Bad Debts Account, and thus reducing the amount of the losses from this cause.

A number of definitions of terms used in connection with Bad Debts are given at the end of this lesson.

Complete Cash Book

In the simple form of Cash Book which was shown in Lesson No. 4, provision was made for the recording of cash receipts and payments only. In modern business a large proportion of payments are made through banks by means of cheques, cash being used for sundry small items only.

It is possible to devise a Cash Book in which may be recorded not only cash receipts and payments of cash, but, in addition, the various bank transactions, and also items of discount allowed or received. For this purpose it is necessary to have three sets of columns on each side of the book, one being for discount, one for cash transactions, and the third for bank items.

In this way provision is made for three separate accounts being kept in the Cash Book, and the student will be well advised to bear this fact in mind when working an exercise in which a three-column Cash Book is included.

The specimen shown on the next page is the generally accepted form of complete Cash Book.

The Cash column needs little explanation, as it is precisely the same as the simple Cash Book set out in Lesson 4. Receipts of cash are debited and payments are credited. If the student will look upon himself as a cashier, he will see that he is represented as having £50 in cash on July 1st, and that at July 31st his cash balance in hand is £95 4s. 0d.

The bank column may be somewhat difficult to understand. A payment made by cheque does not affect the cash balance in any way. Payment is made through the Bank, and the entry must therefore be made on the credit side of the Cash Book in the Bank Column.

Cheques received are treated as cash, and, being placed in the Cash Box, are entered in the cash column on the debit side.

It is possible to arrange that all cheques received should be paid into the Bank at once, in which case it would be possible to enter them direct into the bank column on the debit side. This is not recommended.

The transactions which the student is likely to find confusing are those where money is paid from the Office Cash into the Bank, or where money is withdrawn from the Bank for Office purposes. Supposing he, acting as cashier, pays from the Cash

Dr. CASH BOOK *Cr.*

19..		Receipts	Discount £	Discount s.	Discount d.	Office £	Office s.	Office d.	Bank £	Bank s.	Bank d.
July	1	To Balance				50	–	–	500	–	–
,,	4	,, J. Heron		2	–	40	–	–			
,,	7	,, Sales				35	–	–			
,,	9	,, F. Dodd		–	10	30	–	–			
,,	15	,, Cash							50	–	–
,,	20	,, Bank				20	–	–			
			£	2	10	175	–	–	550	–	–
July	31	To Balance				95	4	–	430	–	–

19..		Payments	Discount £	Discount s.	Discount d.	Cash £	Cash s.	Cash d.	Bank £	Bank s.	Bank d.
July	2	By Trade Expenses ..				5	–	–			
,,	8	,, Purchases				17	–	–			
,,	10	,, W. White		5	–				100	–	–
,,	12	,, Rates				7	16	–			
,,	15	,, Bank				50	–	–			
,,	20	,, Cash							20	–	–
,,	31	,, Balance				95	4	–	430	–	–
			£	5	–	175	–	–	550	–	–

£50 into the Bank, it will be necessary for him to record the double effect of the transaction in the Cash Book.

Similarly, if he draws from the Bank by means of a cheque the sum of £10 it will be necessary to credit the Bank Account and to debit the Cash Account.

The principle of double entry is carried out as between the Cash and Bank Accounts by one being debited and the other credited. For this reason it is not necessary to post into the Ledger the transactions between the Cash and the Bank, these being referred to as "Contra Entries."

The Bank column is balanced in the same way as the Cash column, the balance representing the amount standing to the trader's credit in his Banking Account, assuming that it is a debit balance. A credit balance would represent an overdraft.

The various items in the Cash and Bank columns, with the exception of the Contra items, are posted to their respective Ledger accounts; the entries in the Bank column being posted as "To (or By) Bank."

When a payment is received, and at the same time a sum is allowed as discount, the cash received is recorded in the Cash column, whilst the discount allowed appears in the Discount column.

When a payment is made and Discount is allowed, the transaction will be treated as shown in the item entered in the specimen Cash Book on July 10th, when £100 was paid by cheque to W. White, who allowed a discount of £5. The totals of discount columns are transferred to the Discount Account in the Ledger, being entered in the Ledger on the same side as they appear in the Cash Book.

When posting the ordinary items from the Cash Book, they will be transferred to the opposite side of the corresponding account in the Ledger, thus completing the double entry.

When money is withdrawn from the Bank for private purposes, it is not treated in the same way as a withdrawal for the use of the business, so that it is not a "Contra" entry. It is credited in the Bank column and posted to a Drawings Account.

Definitions of Terms

An Insolvent Person is one who is not able to pay his debts in full.

A Bankrupt is an insolvent person whose affairs have been placed before the Court, by whom he has been declared a bankrupt.

Composition.—This term is used when a person agrees with his creditors that they shall accept a part only of the amounts due to them in settlement of the whole.

A Dividend, when used in this connection, means the proportionate distribution to creditors of so much of the debtor's assets as have been realised. F. H.

SHORTHAND.—VI

Key to Exercise 25

1. offer, flowed, virtue, arrival, Atherley, Ethelred, banner, channel.
2. rumour, enamel, approval, flavour, stifle, miracle, bravely, eternal.
3. *We-think-the* pickles *are dear at-the* price.
4. *You-may call at this* office *to see our* manager either Friday *or* Saturday.
5. *During-the* storm *we* took shelter *at-the house of Dr.* Drew.
6. *If-the* paper *is equal to-the* last, *we-shall-be* pleased *with-it.*

Key to Exercise 26

Upward and Downward SH.—In the reading of Exercise 25, the student's attention was, no doubt, specially drawn to the outline for the word *shelter*, in which upward *sh* is written. This outline shows that *sh* may be written upward or downward.

When *sh* is the only stroke in an outline, it is always written downward; thus—

ash, shy, sash, shows,
swish, usher, shrew.

When preceding or following another stroke, *sh* may be written upward or downward, whichever form gives the better joining; thus—

shave, sheath, shale, shaker,
sugar, shackle; shape, shade,
shipper, shiny, shore, sherry;
fish, lavish, dash, trash,
brush, afresh, push, blush,
clash, mash.

NG-KeR, NG-GeR.—Words such as *tinker* and *linger* require a little attention.

tinker = ting-ker; linger = ling-ger.

In other words, these examples contain the sounds *ng-ker*, *ng-ger* respectively, and such sounds are represented by *ng* hooked for *r*. Thus we have *ng*, *ng-ker* or *ng-ger*, as in—

tinker, linger, banker, drinker.

NG-R.—The words *singer* and *ringer* contain the sounds *ng-er*, and for these stroke *ng* and downward *r* are written; thus—

singer, ringer, flinger.

Shr, Shl.—*Shr* is generally written *downward*; *shl* is generally written *upward*; but either the upward or the downward *shr*, *shl* may be written in order to give a convenient joining; thus—

SHR: *shrub, shriek, shrill,*
shrive, pusher, masher;
fisher, lavisher,
vanisher.

SHL: *shelf, Sheldon, official,*
partial, essential;
commercialism.

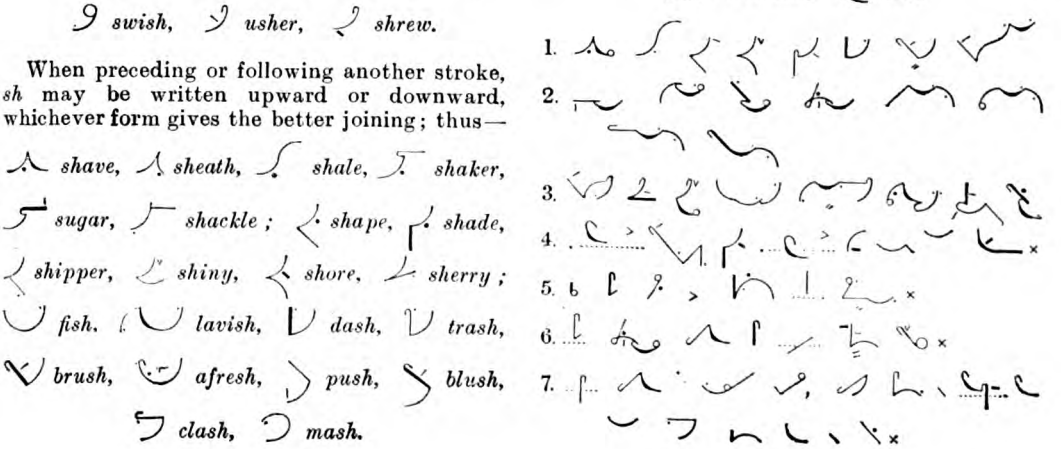
Various syllables are represented by the hooked forms, as in—

sea-shell, develop, mouthful,
Ayrshire, effectively, survival,
shrapnel, enlightener.

Exercise 27

GRAMMALOGUES

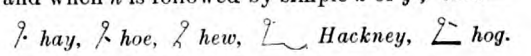
at all, tell, till; deliver-ed-y;
valuation, evil.



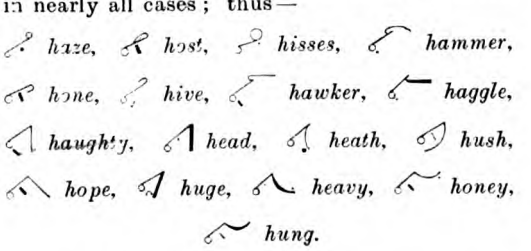
Key to Exercise 27

1. shaves, shell, shop, shire, shuttle, dish, Prussia, polishing.
2. conquer, lingers, bankers, cheese-monger, ringer, slinger, clinger, bringer.
3. polisher, shrug, shrives, finisher, Lancashire, slavishly, Dunlop, bravely.
4. *The valuation of-the* property showed *the evil of-the* law now *in* vogue.
5. *He-has delivered-the* hay *to-the* dealer *at* Hackney.
6. *At-all-the* cheese-mongers *we-have delivered our* Autumn prices.
7. *Till we-have an* answer *to-ours, we-shall tell-him to* overdraw *for any* cash *he-may have to* pay.

The Aspirate.—There are two alphabetic forms for the aspirate: the downward and the upward. In Exercise 27 the outlines for the words *hay* and *Hackney* illustrate the use of the downward form. Downward *h* is written when it is the only consonantal sign in a word, and when *h* is followed by simple *k* or *g*; thus—



When *h* is followed by a circle, loop, or hook, or by a downstroke, the upward form is written in nearly all cases; thus—



Revision.—The student should bear in mind that it is just as important to revise principles already studied as it is to proceed with new ones.

Up to the present we have considered the following:—

(*a*) The alphabet, the long and short vowels, and the diphthongs and triphones.

These are very important and should not be neglected.

(*b*) Grammalogues.

Make a point of revising these at short intervals.

(*c*) Phraseography.

The joining of word-forms is an interesting subject for the shorthand-writer and is of vital importance when letters and other matter are taken down from dictation.

(*d*) Circles, and Loops, and Hooks.

Note that the circles *s*, *sw*, and *ses*, loops *st* and *ster* and hook *l* are written on the same side of a straight stroke.

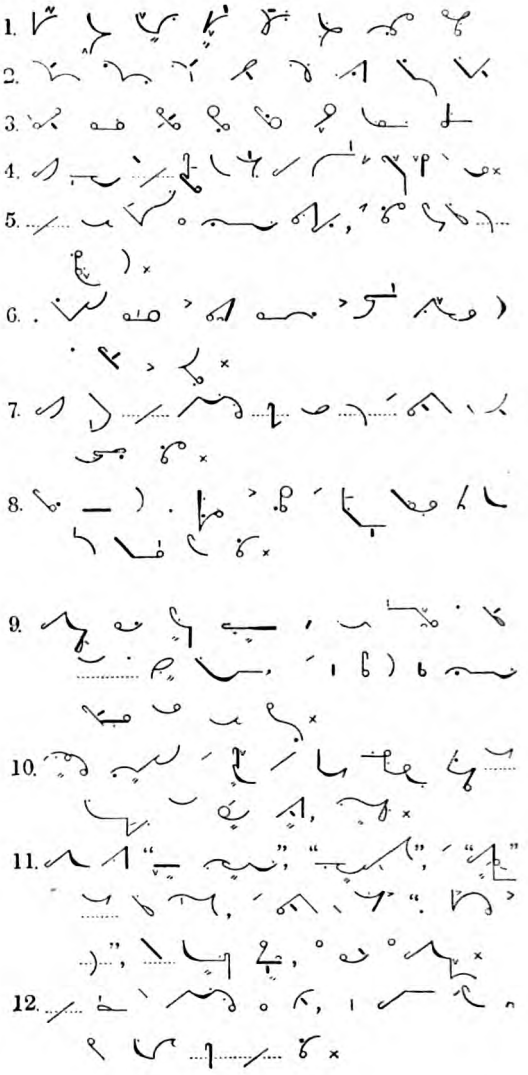
(*e*) The vowel-indicating power of strokes *s*, *r* and *l*.

Remember that ability to apply the rules relating to these strokes will facilitate the practical work of a shorthand-writer.

(*f*) Upward and Downward *h*.

These are provided in order to give facile outlines.

Exercise 28



Exercise 29

1. pale, tale, power, fair, Cecil, fossil, Folly, noiseless.
2. arm, room, era, raises, erases, aright, share, sherry.
3. sets, spies, switches, states, traces, mask, risk.
4. Please mail *us your* price-list *of*-brushes.
5. *The* banker *is* full *of* zeal *for-his* daily duties.
6. Chili *is on-the* west coast *of* South America.
7. *You-will-see-the* key *to-this*-exercise *in-the next* lesson.

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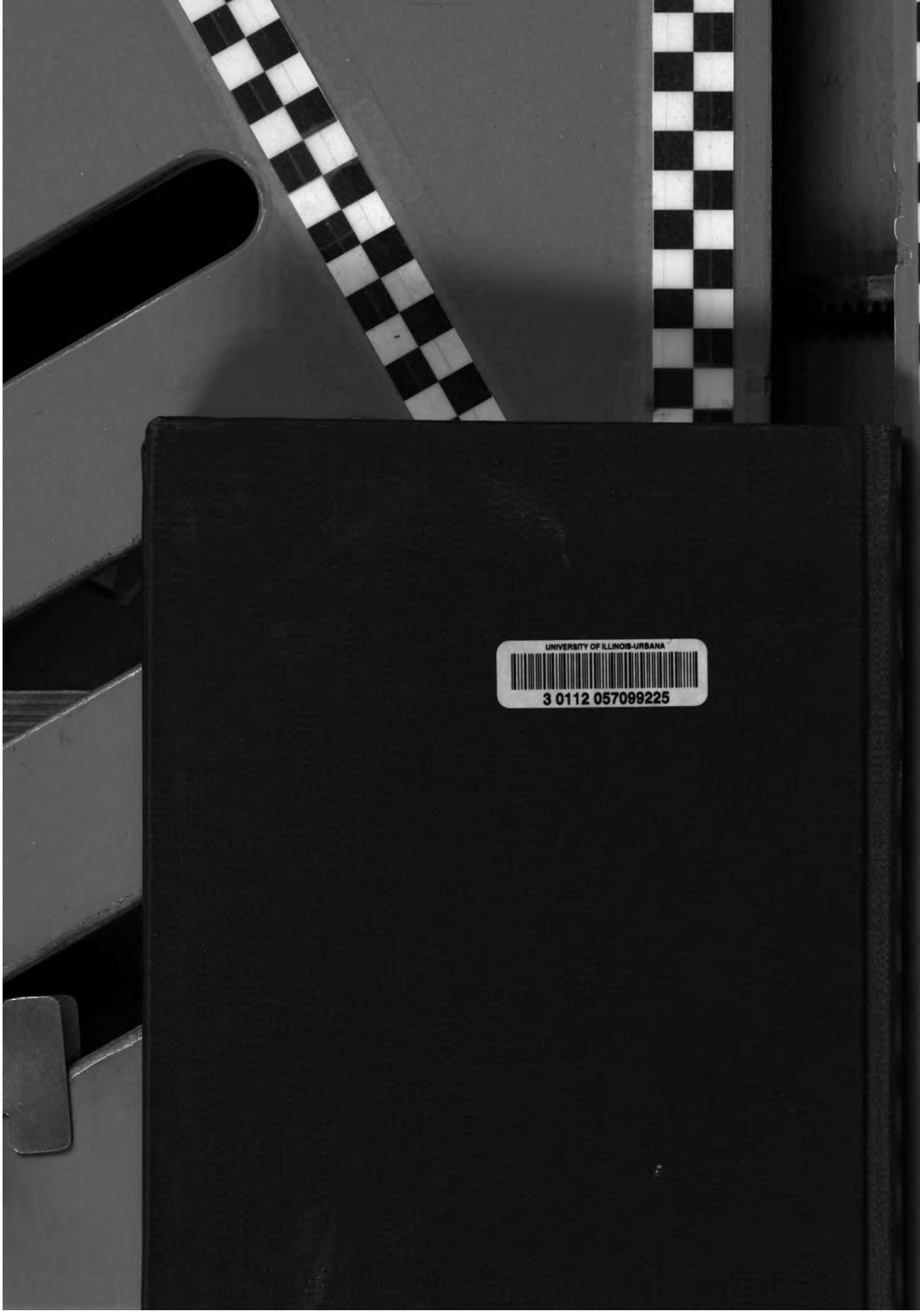
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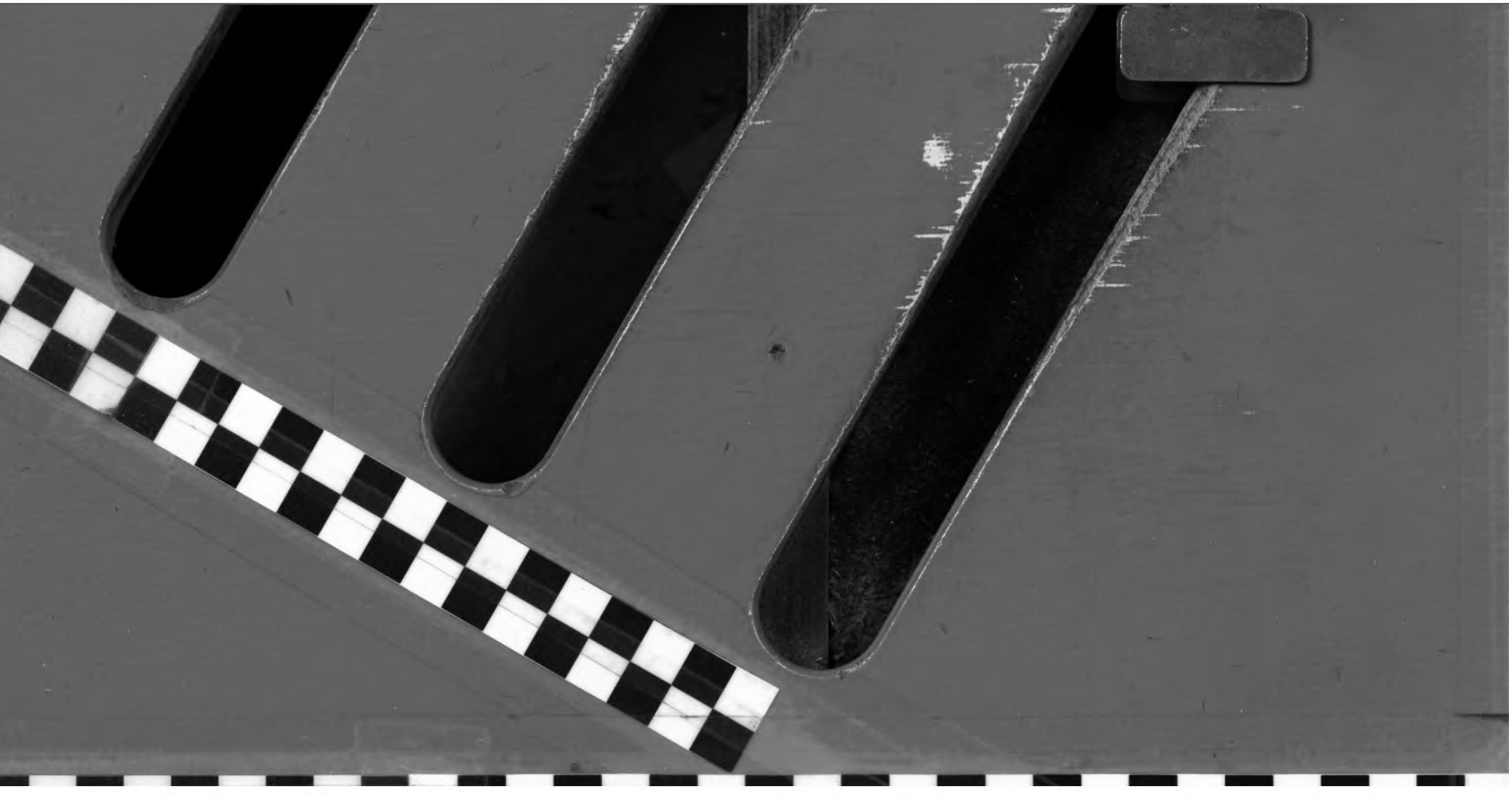

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